Manual Amendment Summary

Manual Type		HJ364 MECS
Part Number		089039
Revision	R1	18/05/10
Amendment	A5	10/06/13

Refer to change notice 21583 for amendments

Manuals check List

One check list to be completed and returned with each order

- ❑ Print on Canon 100gsm A4 paper
- ❑ Print No Scaling!!!
- ❑ Print Double Sided Black and White
- ❑ Standard front cover (Die Cut) & Back covers printed 300gsm colour.
- ❑ Front and back covers Matt Laminate
- ❑ Punch 4 holes - ensure correct spacing and clean punched through
- ❑ White wire bound (Wire size to be appropriate for thickness of manual)
- ❑ Pages to be trimmed
- ❑ Check for missing images - grey boxes (Contact C.W.F.Hamilton)
- ❑ Check for colour consistency within a batch
- ❑ Ensure manuals are package correctly to prevent damage during transport
- ❑ Ensure file name and Manual Part # matches order

HamiltonJet

www.hamiltonjet.co.nz

Installation and Service Manual

HJ364

Control Manual

R1A5

Manual Type		HJ364 MECS
Part Number		089039
Revision	R1	18/05/10
Amendment	A5	10/06/13

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1 - Introduction

1

In This Section

1 Limited Warranty

Terms of coverage

C.W.F. Hamilton & Co. Ltd. (Hamilton Jet) warrants to the original purchaser that each new Hamilton Jet product is free from defects in material and workmanship under normal use and service for the warranty period.

- In the event that a warranted defect in material or workmanship is disclosed to Hamilton Jet within the warranty period, Hamilton Jet's obligation is limited to, at its option, repairing or replacing the defective product, or component part at its factory or such other location as may be designated by Hamilton Jet.
- Defective products shall be returned to Hamilton Jet or its authorised service representative for inspection with transportation charges prepaid by the purchaser to the location specified by Hamilton Jet.
- This warranty only applies where the product is shown, to the satisfaction of Hamilton Jet, to be defective in material or workmanship during the warranty period.
- Hamilton Jet will supply parts required for warranty repairs free of charge and pay reasonable authorised labour costs.
- To the extent permitted by law, this warranty sets out the original purchaser's exclusive remedies with respect to the product covered by this warranty. In the event that Hamilton Jet determines it is unable to repair or replace any component part(s) found to be defective in materials and/or workmanship, Hamilton Jet's warranty liability shall be limited to payment by Hamilton Jet to the original purchaser of an amount not to exceed the value of the defective part(s), together with shipping charges, if any, incurred.
- All products removed or replaced under the warranty shall become the property of Hamilton Jet.
- All warranty claims shall be lodged with Hamilton Jet or its authorised distributor.

Warranty period

- The warranty period for Hamilton Jet products is limited to a period of twenty-four (24) months from the date of original shipment from the Hamilton Jet factory, or twelve (12) months from the vessel launch date, whichever occurs first.

Limitation of liability

- This warranty is extended only to the original purchaser, and is not transferable to or assignable to any other person or entity, and does not extend to future performance.
- In no event will Hamilton Jet, its distributors, or affiliates be liable for any incidental, punitive or consequential losses, inconveniences, damages or other costs resulting directly or indirectly from any defect in the product covered by this warranty, including, but not limited to, loss of use, revenue or profit.
- Hamilton Jet reserves the right to change its product through changes in design or materials without obligation to incorporate such changes in any products previously manufactured, but any improvement or changes may be incorporated in replacement product.

This warranty does not extend to failures, damages or defects resulting from the following:

- What Hamilton Jet determines to be, misuse, abuse, overloading, improper application, improper transportation or storage, abnormal wear and tear, negligence, carelessness, accident, natural calamity, vandalism, fouling caused by foreign material, peculiar water conditions or chemicals, or other circumstances over which Hamilton Jet has no control.
- Operation or maintenance in any way other than in accordance with the operating and maintenance instructions of Hamilton Jet.
- Vessel-to-shore electrical connections that change the corrosion potential of the vessel. For vessels equipped with shore power this warranty will not extend to the product unless an isolating transformer or galvanic isolator is fitted as described in the applicable HamiltonJet Product Manual.
- Incorrect installation, as per the applicable Hamilton Jet Product Manual and the applicable Hamilton Jet Designer's Manual. This warranty will not extend to the product unless a negative earth bonding system has been installed in the vessel as specified in the respective Hamilton Jet Product Manual, and a Jet Mainshaft critical speed check carried out to Hamilton Jet's written satisfaction.

This warranty does not cover or provide payment or reimbursement for the following:

- Any product which may have been serviced, repaired or altered in any way by anyone other than Hamilton Jet or a Hamilton Jet authorised facility.
- Any repairs or alterations carried out with the use of parts or accessories not manufactured by Hamilton Jet or its authorised representatives.
- Items incorporated in any Hamilton Jet product (other than by Hamilton Jet) when such items have been manufactured by others or are warranted by their respective manufacturers in favour of the purchaser.
- Used or reconditioned parts.
- The cost of transporting the vessel to a repair facility and for all related towing, harbour, docking, slippage, lifting, moorage, launching or retrieval charges.

No representations or express or implied warranty except as herein stated

- To the extent permitted by law, this limited warranty is the only warranty extended by Hamilton Jet and is in lieu of all other warranties, EXPRESSED or IMPLIED, oral or written and of all other obligations or liabilities, including without limitation any IMPLIED WARRANTIES of MERCHANTABILITY or FITNESS for a PARTICULAR PURPOSE. Except as provided in this warranty the product is sold as is, where is.
- No other person or agent or distributor is authorised to modify this warranty, give any other warranty on behalf of HamiltonJet or to assume for Hamilton Jet any other obligation or liability in connection with the sale of its products.
- In the United States and Canada, some states and provinces do not allow limitations on duration of an implied warranty, or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. This limited warranty gives you specific legal rights and you may also have other rights, which vary from state to state.
- In other countries outside the United States and Canada, you may have statutory rights which cannot be affected or limited by the terms of this Warranty.

C.W.F. Hamilton & Co. Ltd. July 2005 [Rev H]

1 Warranty and Ownership Registration Form

To allow Hamilton Jet to complete its records and in order to assist any claim under the attached Limited Warranty, please complete this Warranty and Ownership Registration Form in full and return as soon as possible by post, facsimile or Email to:

- The Marketing Department, C.W.F. Hamilton & Co Ltd.
- PO Box 709, Christchurch,
- New Zealand.
- Fax, +64 3 348 6969
- Email, marketing@hamjet.co.nz

Hamilton Jet encourages the Distributor to take responsibility for ensuring the Purchaser and the Distributor complete this form at the time of sale and return it to Hamilton Jet. Please complete one form per vessel only.

Jet Model

Serial Number(s)

Delivery Date

Commissioning / In service Date

Vessel/Project

Purchaser

Address

Contact Name

Signed

Distributor

Address

Contact Name

Signed

Office Use Only

Logged By

Project Code

Date

1

General Safety Notice

Warning

A warning is an operation or maintenance procedure, practice, condition or statement which, if not strictly observed, could result in injury or death to personnel.

This is indicated throughout this manual as shown below:

Caution:

A caution is an operation or maintenance procedure, practice condition or statement which, if not strictly observed, could result in damage to, or destruction of equipment or loss of mission effectiveness.

This is indicated throughout this manual as shown below:

Note:

A note contains additional information that will help clarify a procedure.

This is indicated throughout this manual as shown below:

1

2 - Product Description

In This Section

Introduction

The Modular Electronic Control System (MECS) represents Hamilton Jets third generation of electronic controls.

While providing basic vessel operating controls, MECS also provides the following:

- Extensive system monitoring and diagnostic tools.
- A Hand Held Remote Control option for flexible docking control.
- Engine and gearbox control functions.
- The ability to connect with other electronic systems, e.g. Autopilots, Alarm Systems, Dynamic Positioning Systems.
- Full and independent *Normal* and *Backup* controls.
- Quick and easy modular installation.
- Automatic configuration.

For complete MECS Control system technical specifications Refer: "MECS Technical Data" on Page 10-41.

MECS Main Components

MECS consists of various electronic modules which can be connected together to provide complete Electronic Jet Control.

2

Control Panel Module (CPM)

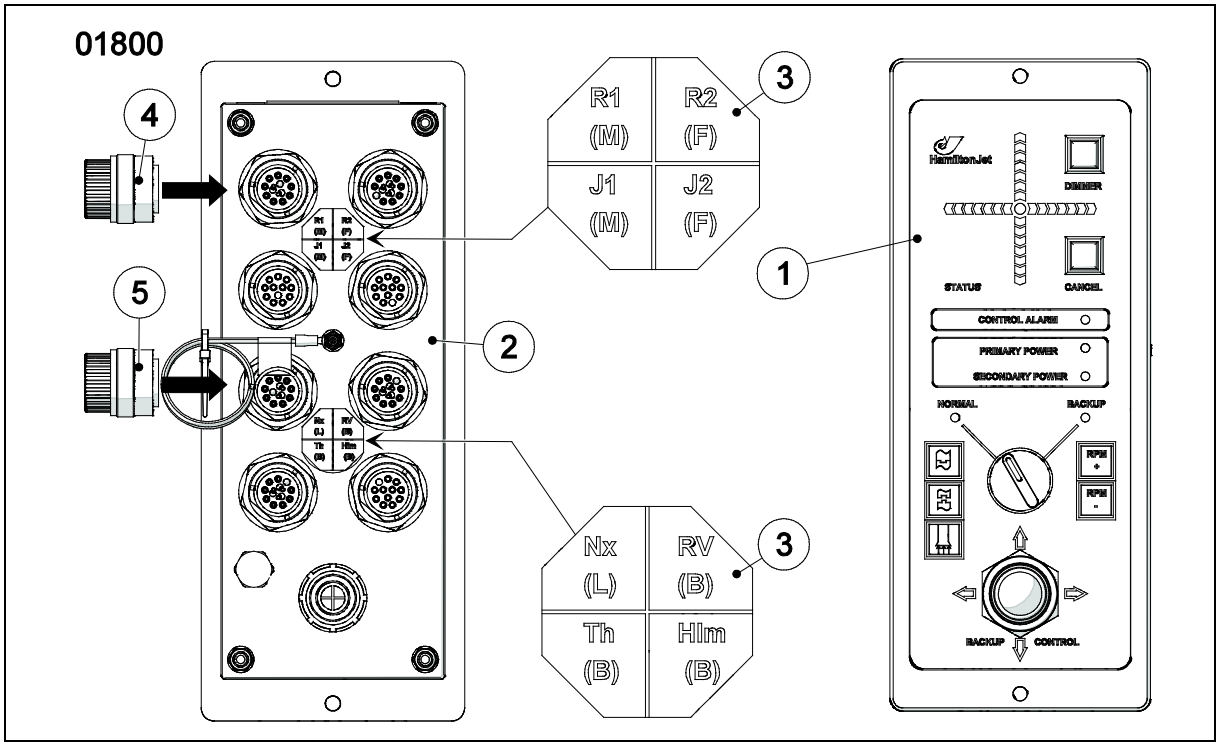


Figure 1: Control Panel Module (CPM)

1	CTCPL14010	Control Panel(Front Elevation)
2	CTCPL14010	Control Panel(Rear Elevation)
3	110392	Connector Label
3	110393	Connector Label
4	110190	Backup Terminator (R1)
5	112744	Network Termination Link (Nx)

Part #	Description
CTCPL14010	Standard Module
CTCPL14012	Special Night Vision Configuration

Control Panel Modules are mounted wherever control of a Jet Unit is required. Separate CPM's are required for each Jet Unit at each Control Station.

The CPM:

- Provides jet position indication.
- Provides alarm indication.
- Includes Backup controls.
- Allows switching between ***Normal*** and ***Backup*** control.
- Includes gearbox controls.
- Provides idle RPM adjustment.

A terminating link ***MUST*** be fitted to both the R1 & Nx connectors of the last Control Panel Module in the chain.

Failure to do so will force the control system into Backup mode.

Network Terminators

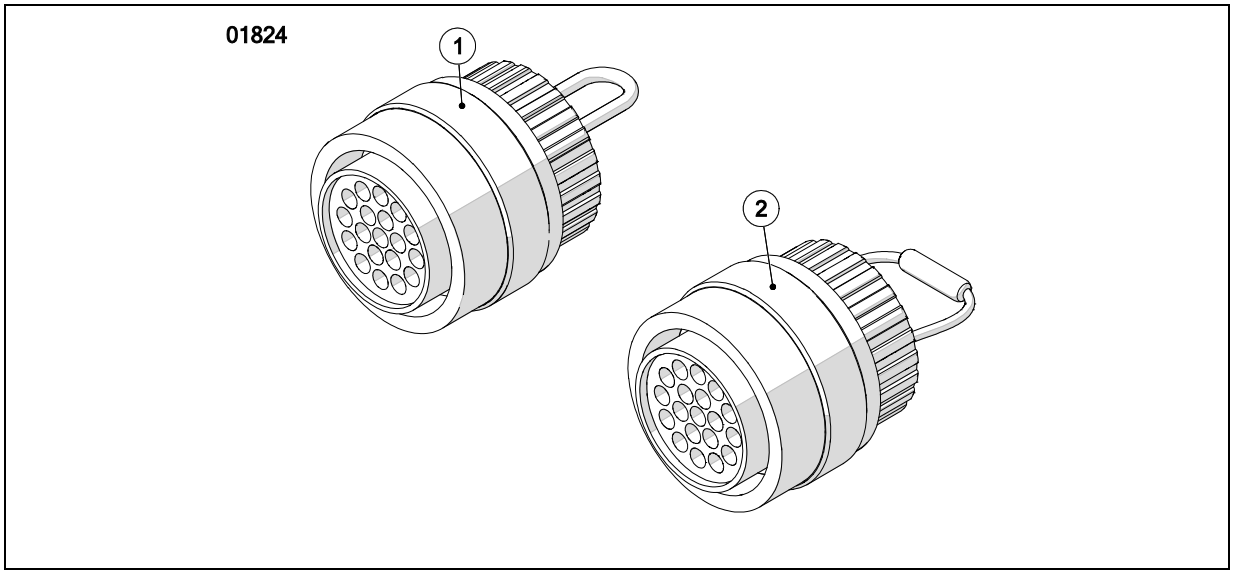


Figure 2: Can Bus Terminating Link

1	110190	Backup Terminator (R1)
2	112744	Network Termination Link (Nx)

A Termination Link must be fitted to the R1 and Nx Connectors on the last Control Panel Module in the chain.

2

Helm Wheel Module

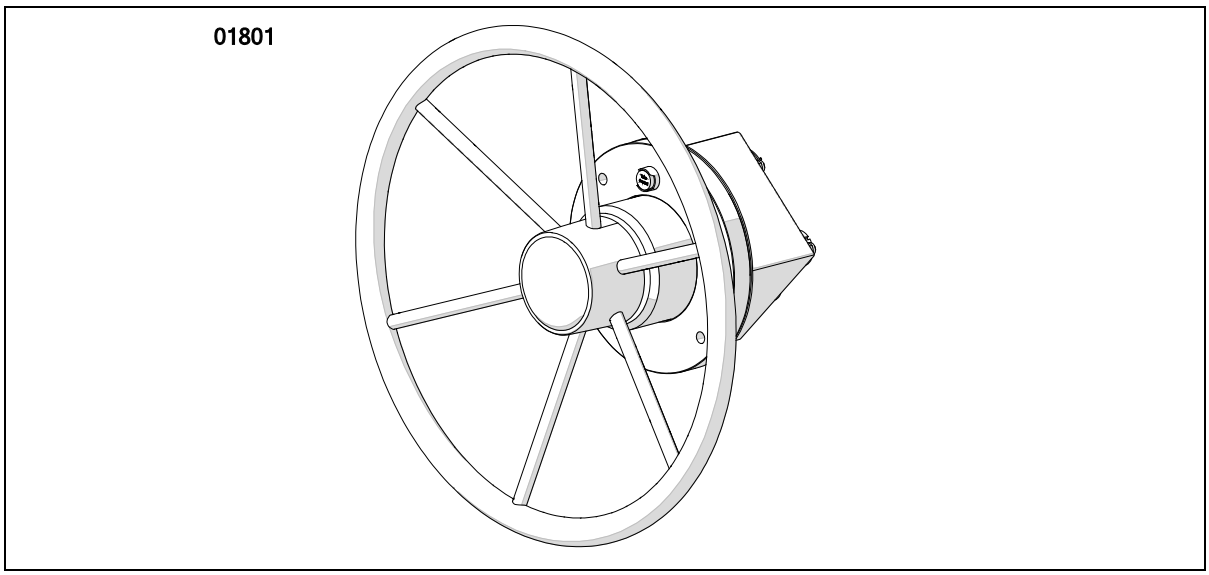


Figure 3: Helm Wheel Module

Part #	Description
CTHLM08006	Standard Module
CTHLM08009	Special Night Vision Configuration

The Helm Wheel Module is the normal method of controlling the Jet Unit steering.

The Helm Wheel:

- Provides Jet steering.
- Includes transfer control between stations.
- Provides adjustable friction.
- Up to two helm units may be fitted to each control station.
- The Helm Wheel can be fitted with various styles and sizes of Wheel.

Joystick Module

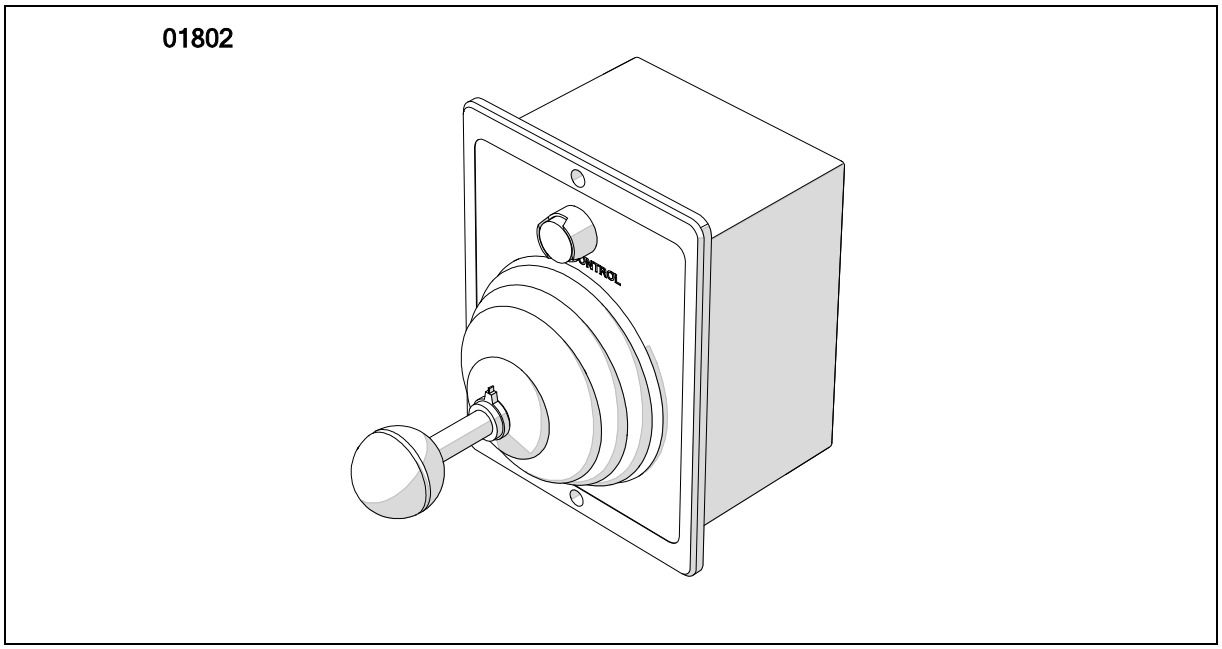


Figure 4:Joystick Module

Part #	Description
CTHLM05003	Non Spring Return
CTHLM05013	Spring Return
CTHLM05014	Special Night Vision Configuration

The Joystick Module is an alternative to the Helm Wheel for controlling the Jet Unit steering.

The Joystick:

- Provides Jet steering.
- Includes transfer control between stations.
- Friction lock and spring return to centre options available.
- Up to two helm units may be fitted to each station.

2

Electronic Tiller Module

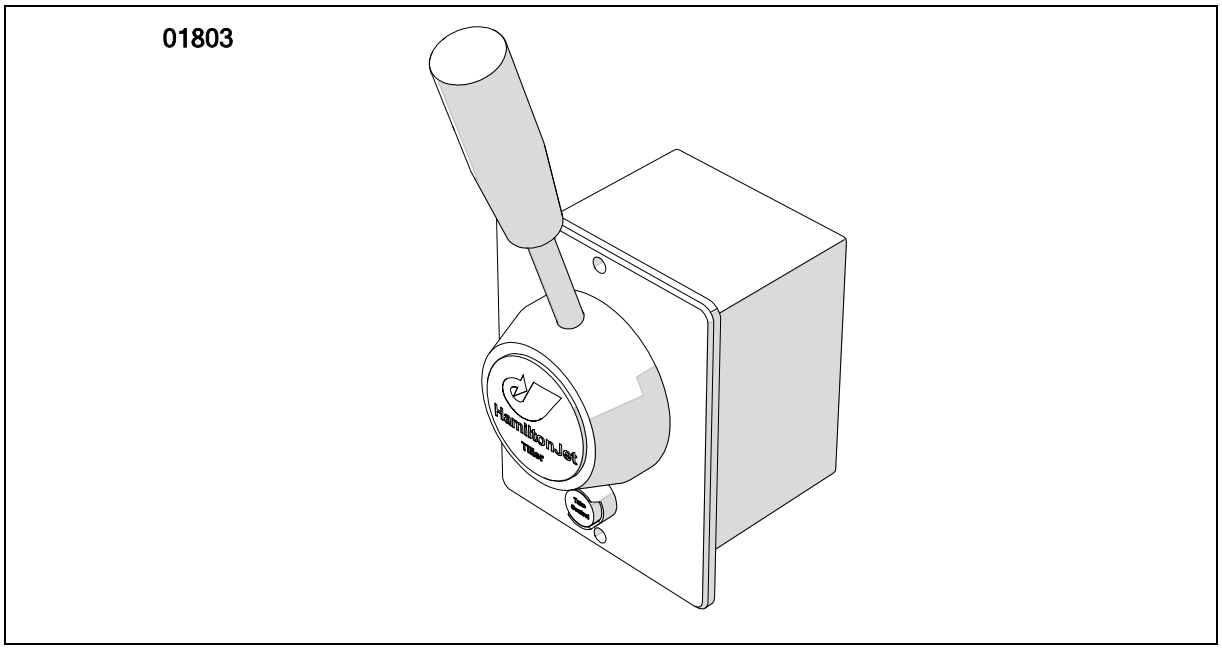


Figure 5: Tiller Module

Part#	Description
CTHLM05005	Standard Long Handle
CTHLM05006	Reverse Long Handle
CTHLM05007	Standard Short Handle
CTHLM05008	Reverse Short Handle

The Electronic Tiller Module is an alternative to the Helm Wheel and Joystick for controlling the Jet Unit steering.

The Tiller:

- Provides Jet steering.
- Includes transfer control between stations.
- Provides adjustable friction.
- Up to two helm units may be fitted to each station.

The Tiller Module can be fitted with a variety of handle options

Control Lever Module

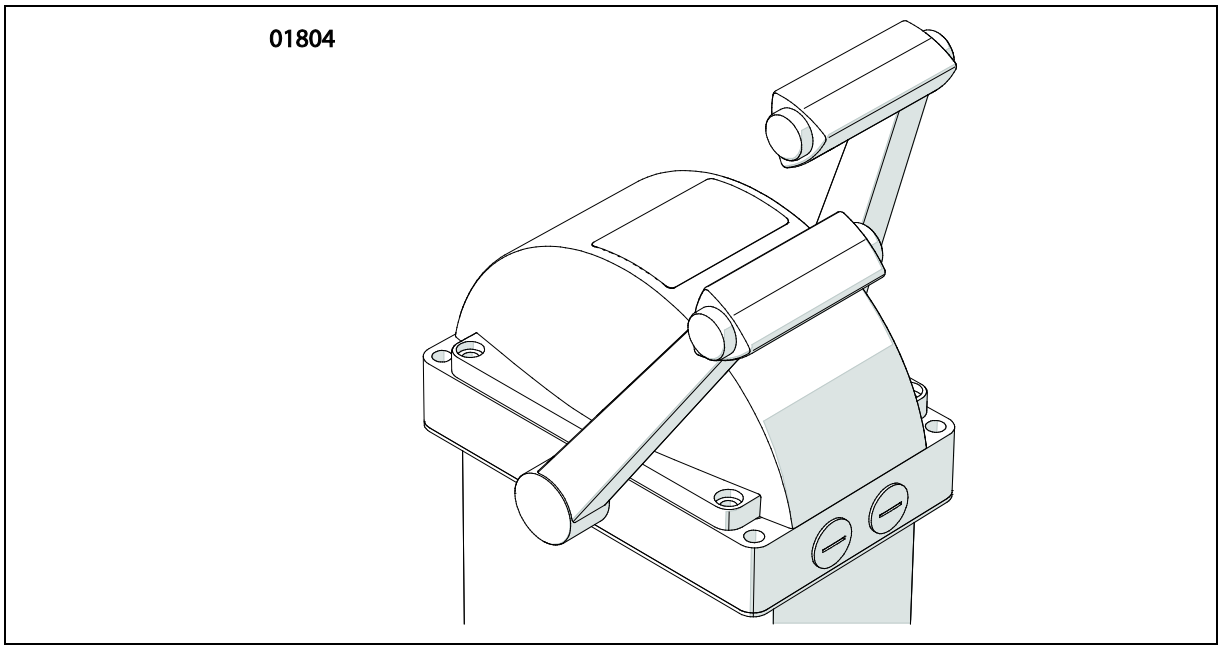


Figure 6:Control Lever Module

Part #	Description
CTCLV04008	Twin Lever Control Lever Module

The Control Lever:

- Controls the Reverse Duct position and engine throttle.
- Has a removable detent for zero speed position.
- Has adjustable friction.

2

Hand held Remote Control (HHR)

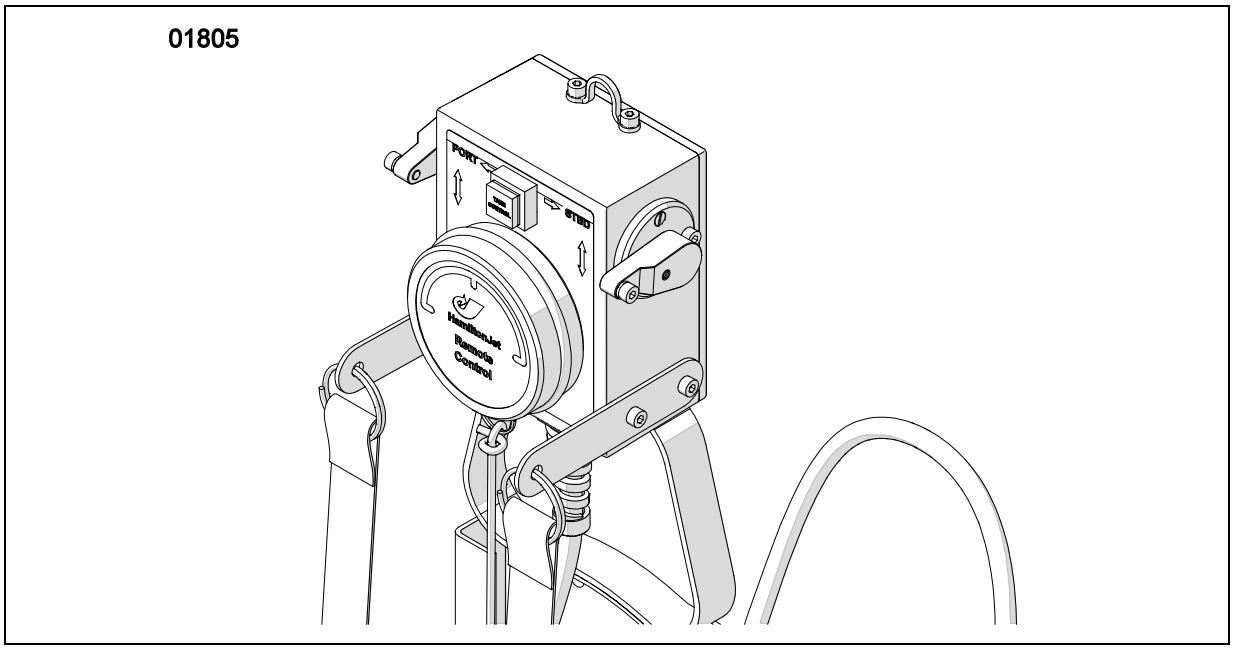


Figure 7: Hand Held Remote Control Module

Part #	Description
CTCPL14004	With 12m Lead
CTCPL14005	With 5m Lead
CTCPL14011	Special Night Vision Configuration

The Hand Held Remote Control Unit is a portable set of Jet Controls allowing Jet Unit operation from up to 10m from a control station.

The Hand Held Remote:

- Provides controls of the Reverse Duct, steering and engine throttle.
- Includes transfer control between stations.
- Has a safety switch that will generate an alarm if the remote is dropped and control is lost.

Handheld Remote Junction Box

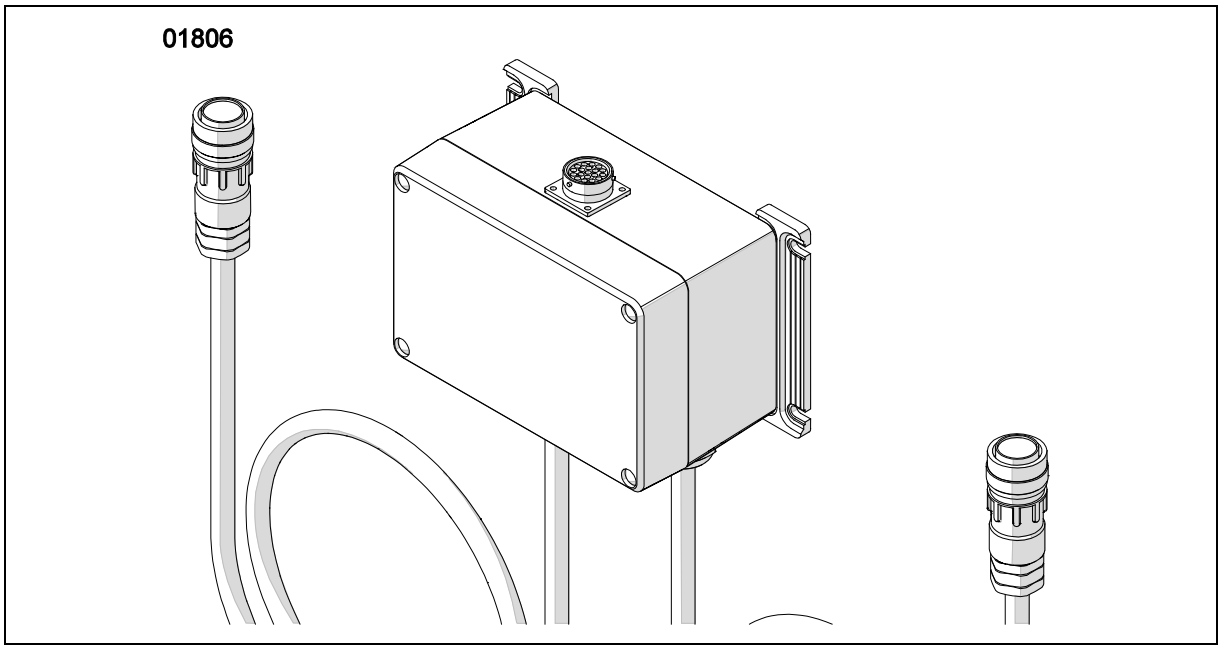


Figure 8:Hand Held Remote Control Junction Box

Part Number CTITF04004:

The Hand Held Remote Junction Box allows a Hand Held Remote Control Unit to be connected to MECS.

The Hand Held Remote Junction Box:

- Provides an interface between the HHR and the jet control system.

2

Autopilot Interface Module (API)

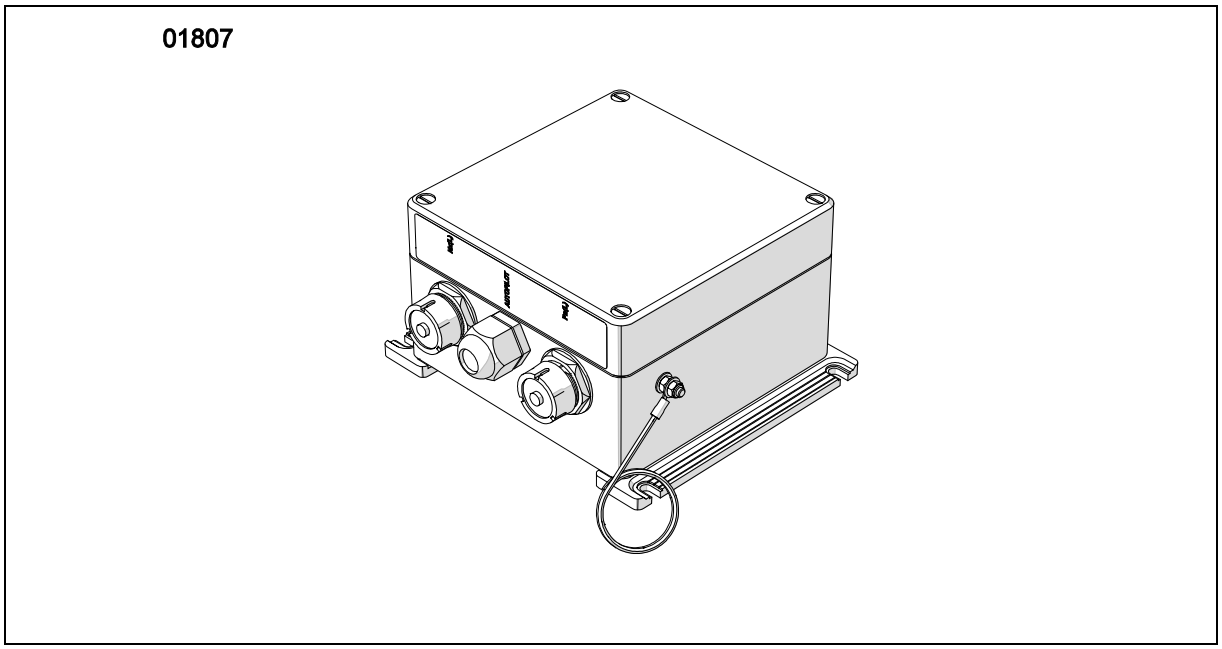


Figure 9:Autopilot Interface Module (API)

Part Number CTITF01003:

Refer: "Connection to an Autopilot" on Page 6-6

The Autopilot Interface Module allows an autopilot to be connected to MECS.

The Autopilot Interface Module:

- Provides an interface between a third party autopilot and the jet control system.

Jet Control Module (JCM)

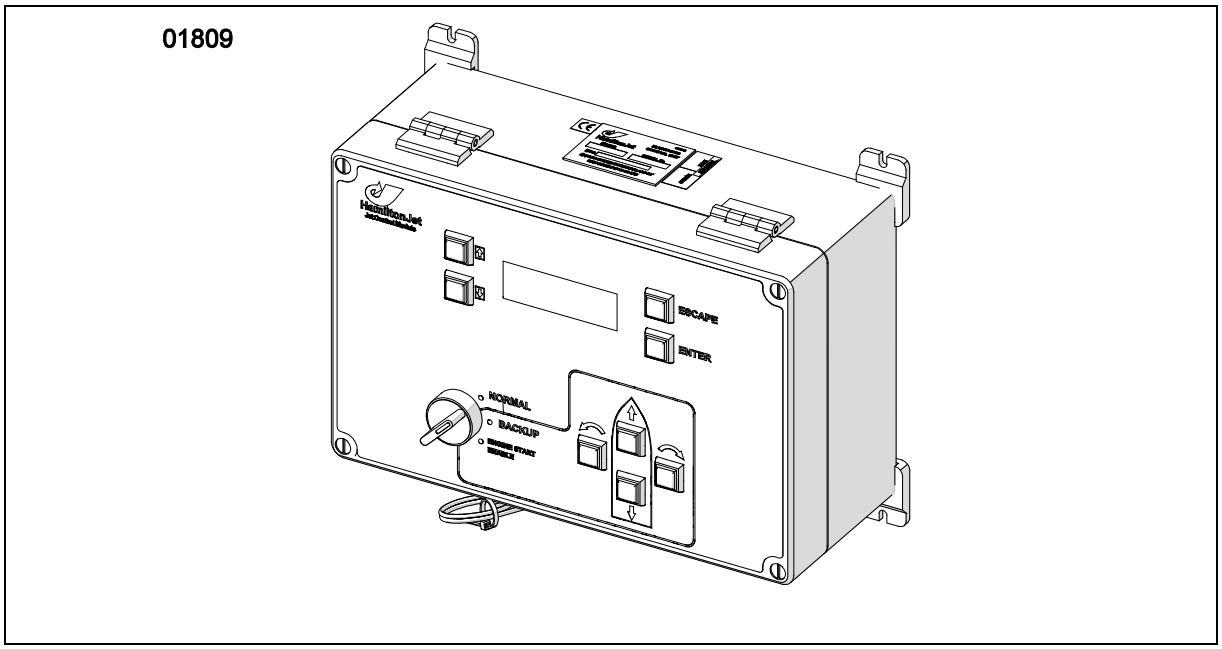


Figure 10: Jet Control Module (JCM)

Part Number CTPCB09008:

The Jet Control Module is the main control centre of the MECS system and should be mounted in the engine or jet compartment.

The Jet Control Module:

- Controls the steering and reverse hydraulics on the Jet Unit.
- Provides a central point for setting up and configuring the system.
- Logs alarms.
- Allows switching between *Normal* and *Backup* control.

2

Engine Control Module (ECM)

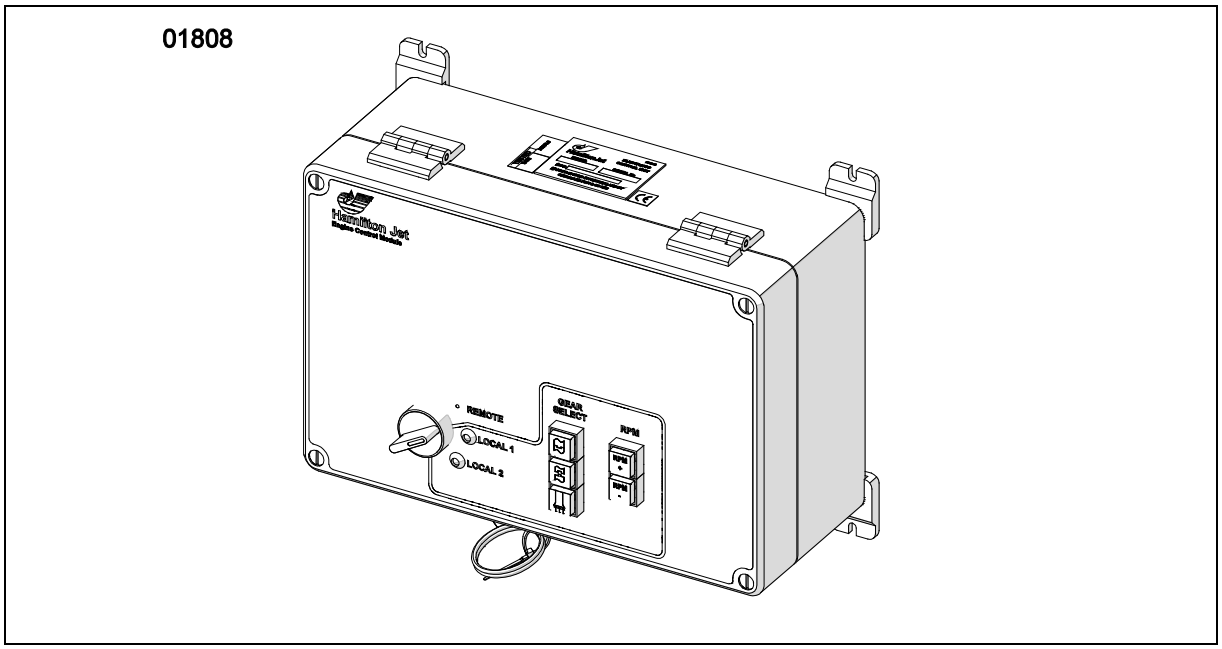


Figure 11: Engine Control Module (ECM)

Part Number CTPCB09005:

Refer: "ECM Terminal Descriptions" on Page 6-4

The Engine Control Module is where the engine and gearbox connects to MECS. It is normally mounted in the engine room.

The Engine Control Module:

- Sends primary and the secondary throttle signals to the connected engine.
- Gets feedback signals from the engine.
- Provides gearbox control.
- Gets gearbox position feedback signals.
- Provides engine start and gear change interlocks.

Jet Junction Box (JJB)

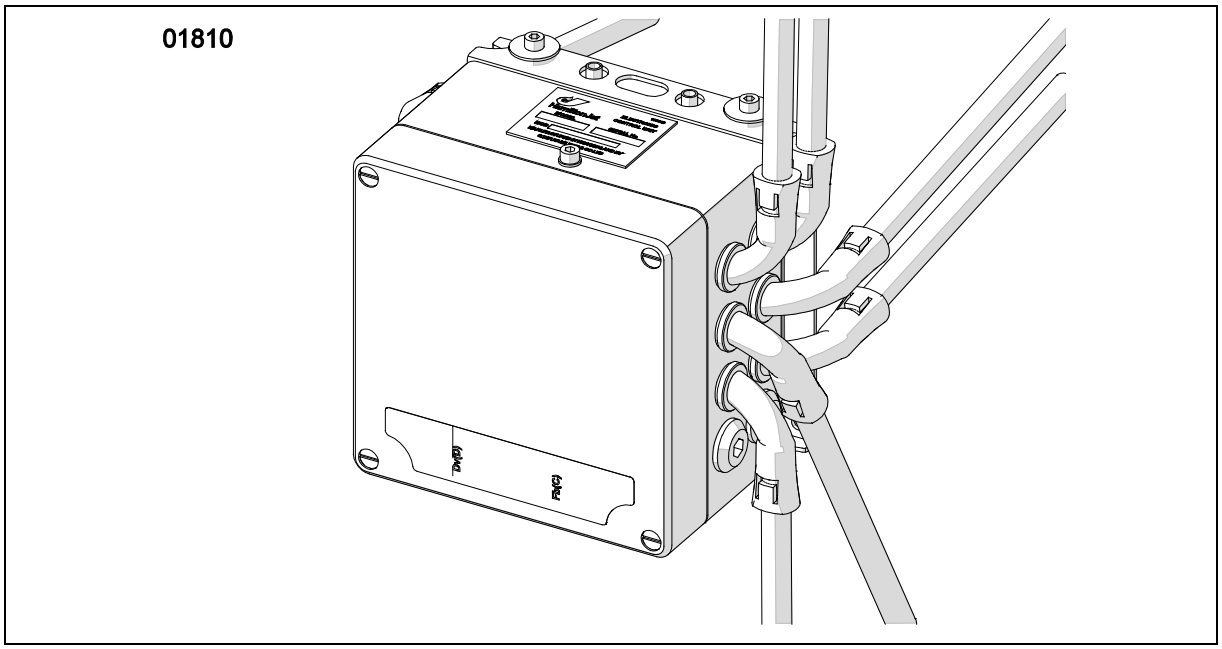


Figure 12: Jet Junction Box (JJB)

Part Number CTITF03004:

Refer: "Jet Unit Junction Box" on Page 6-7

The Jet Junction Box is normally mounted on the Jet Unit but can be mounted remotely if required. It provides the connection point for drive and feedback signals to and from the Jet Unit.

The Jet Junction Box:

- Supplies power to sensors on the Jet Unit.
- Sends sensor information to the Jet Control Module.
- Sends drive signals to the hydraulics.

2

Power and Interlock Module (PIM)

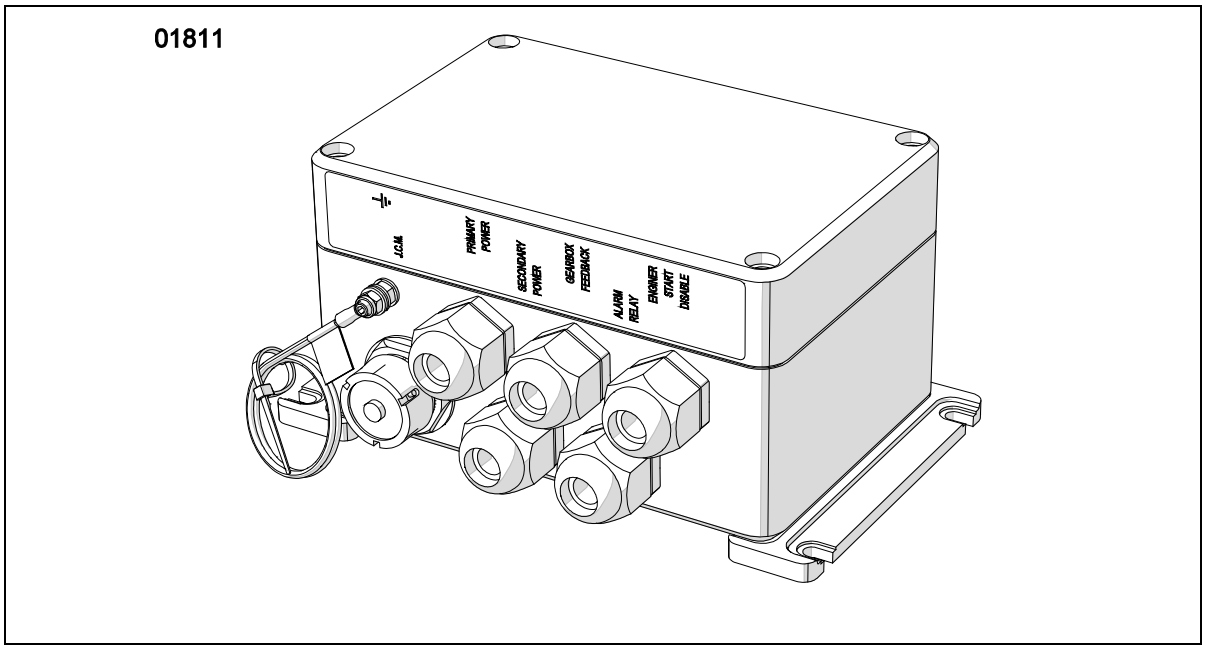


Figure 13: Power and Interlock Module (PIM)

Part Number CTITF04002:

Refer: "Connect to the Power and Interlock Module (PIM)" on Page 6-5

The Power and Interlock Module is where the ships power is connected to MECS.

The Power and Interlock Module:

- Receives raw ship Primary and Secondary power.
- Sends filtered Primary and Secondary power to MECS.
- Provides an Engine Start Interlock Relay.
- Provide a System Alarm Relay.
- Provides an auxiliary power supply for external use.

Manoeuvring Joystick Module (MJM)

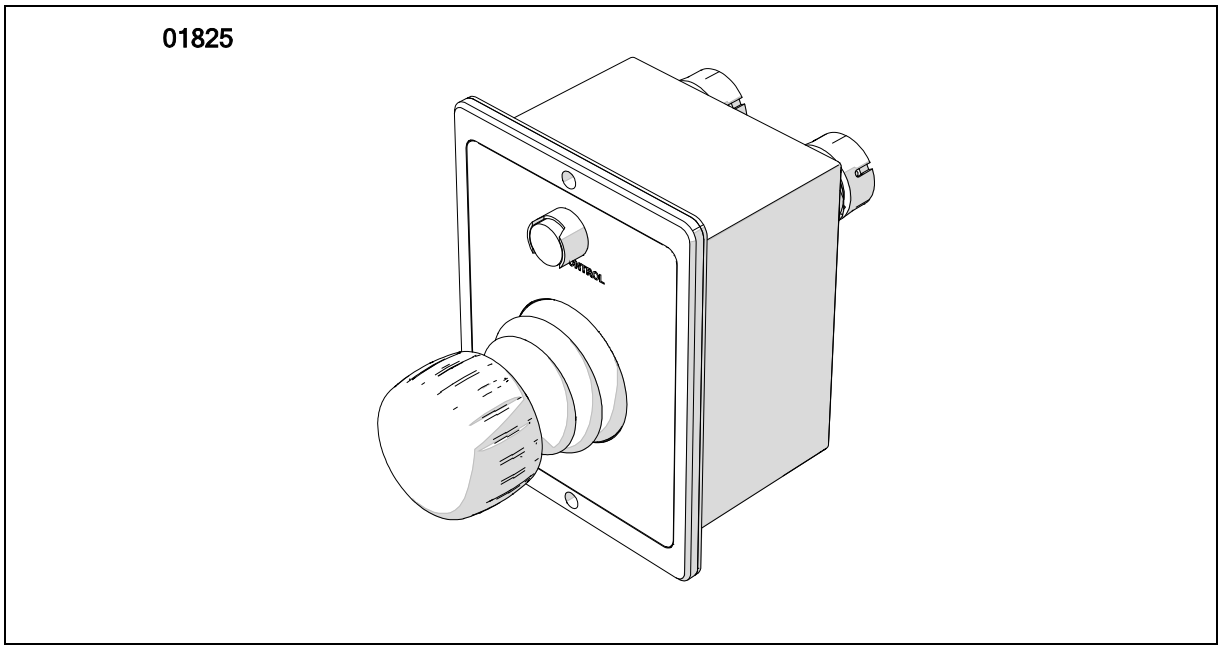


Figure 14: Manoeuvring Joystick Module (MJM)

Part#	Description
CTCLV07004	Standard Three Axis Joy Stick
CTCLV07005	Special Night Vision Configuration

The Manoeuvring Joystick Module provides control of all Reverse Ducts, Steering and Engine RPM.

Designed to simplify manoeuvring while docking.

The Manoeuvring Joystick Module:

- Provides control over the Reverse Ducts, engine RPM and Steering.
- Uses helm compensation from the CPM to help control vessel rotation.
- Includes transfer control between this and the primary controls.
- Spring return to centre.
- Up to one MJM may be fitted as a secondary control at each station.

Oil Pump Starter

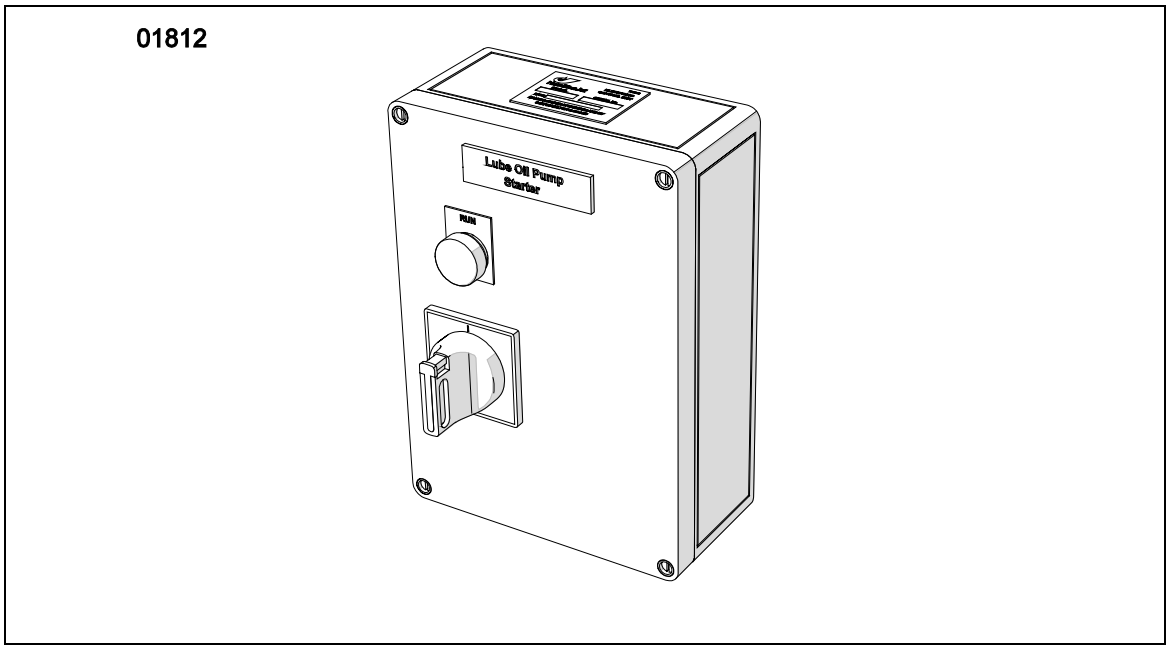


Figure 15: Oil Pump Starter

Part#	Description
CTPCB10001	Bearing Oil Pump Starter (0.8-1.2 Amp)
CTPCB10002	Auxiliary AC Power Pack Oil pump Starter (8-11.5 Amp)
CTPCB10003	Auxiliary AC Power Pack Oil pump Starter (5.5-8 Amp)

Refer: "Bearing Housing Oil Pump Starter" on Page 6-7

Larger Jet Units require an Oil Pump to circulate oil around the Bearing Housing.

Some Jet Units can also be fitted with an Auxiliary Oil pump to allow the hydraulics to be operated while the engines are not running.

The oil pump starter provides control and overload protection for these Oil Pumps.

Dynamic Positioning Interface Module (DPI)

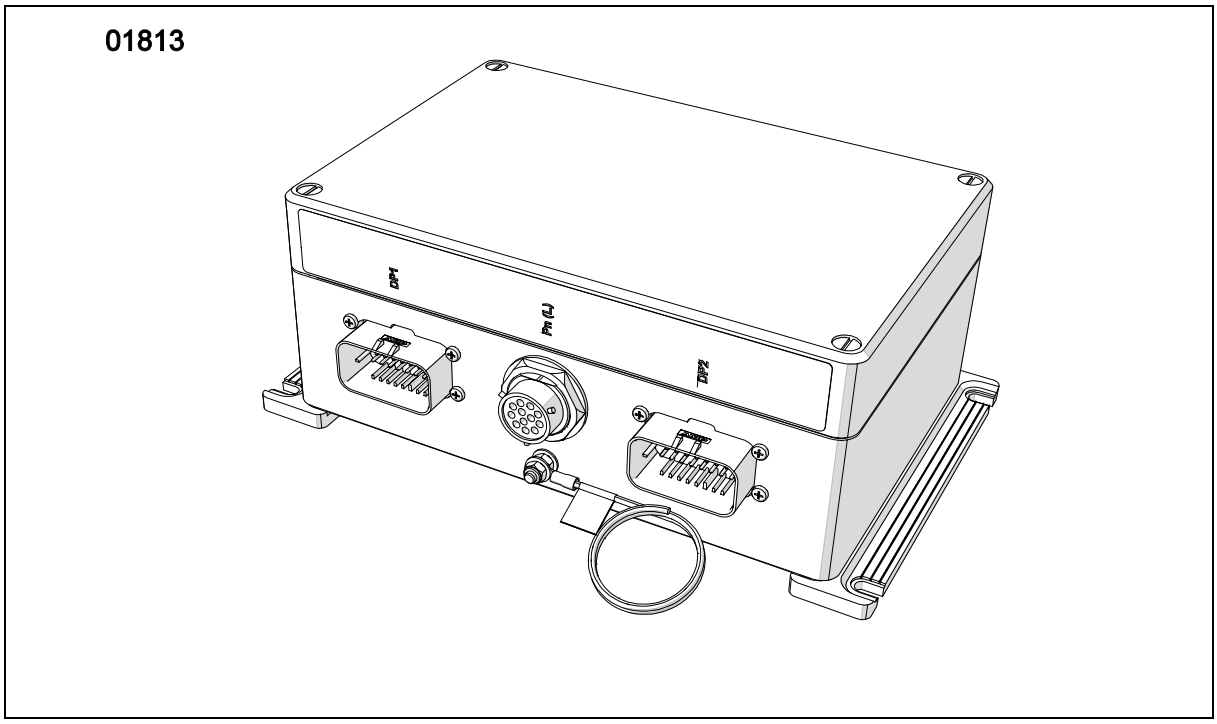


Figure 16: Dynamic Positioning Interface Module

Part #	Description
CTITF01005	Dynamic Positioning Interface Module (DP0)
CTITF01008	Dynamic Positioning Interface Module (DP1)
CTITF01012	Dynamic Positioning Interface Module (DP2)

Refer: "DPI Signals" on Page 3-20

The Dynamic Positioning Interface Module allows MECS to connect to a number of proprietary Dynamic Positioning Systems.

- When MECS is operating in DP mode, the Dynamic Positioning System has full control over the water jet thrust direction and magnitude.
- One DPI is required for each jet.
- The DPI provides analogue and digital inputs and outputs for interfacing with the Dynamic Positioning System.
- The DPI has two independent, isolated interfaces that may be connected to a primary and secondary Dynamic Positioning System to meet DP2 class requirements. For DP0 requirements only one interface is used.
- If a DPI System is used the Jet unit will be fitted with an Sensor to monitor shaft RPM.

2

Voyage Data Recorder Interface

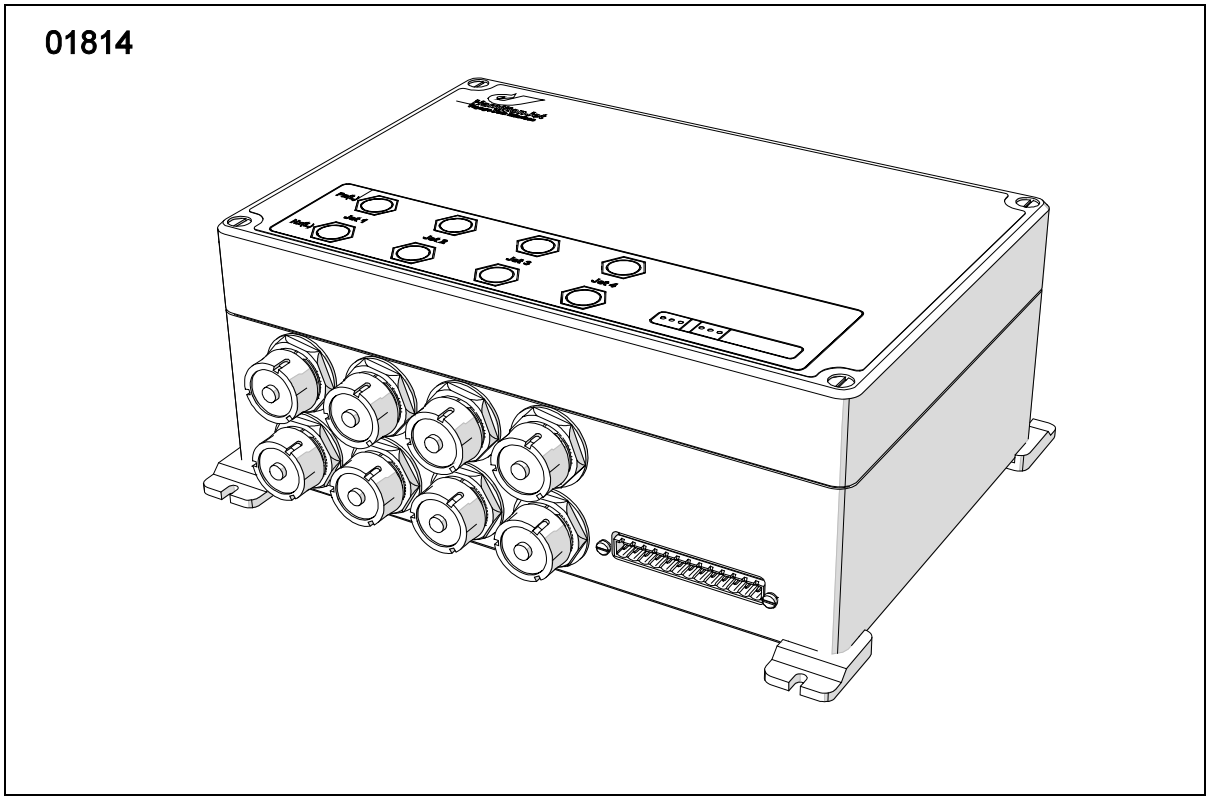


Figure 17: Voyage Data Recorder Interface

Part Number CTITF01011

The Voyage Data Recorder Interface collects data from all connected MECS control Can buses then translates the data into RS485 serial sentences for controlled transmission to third party monitoring or recording equipment. See document 086219 Waterjet Controls NMEA 0183 Binding

System Cables

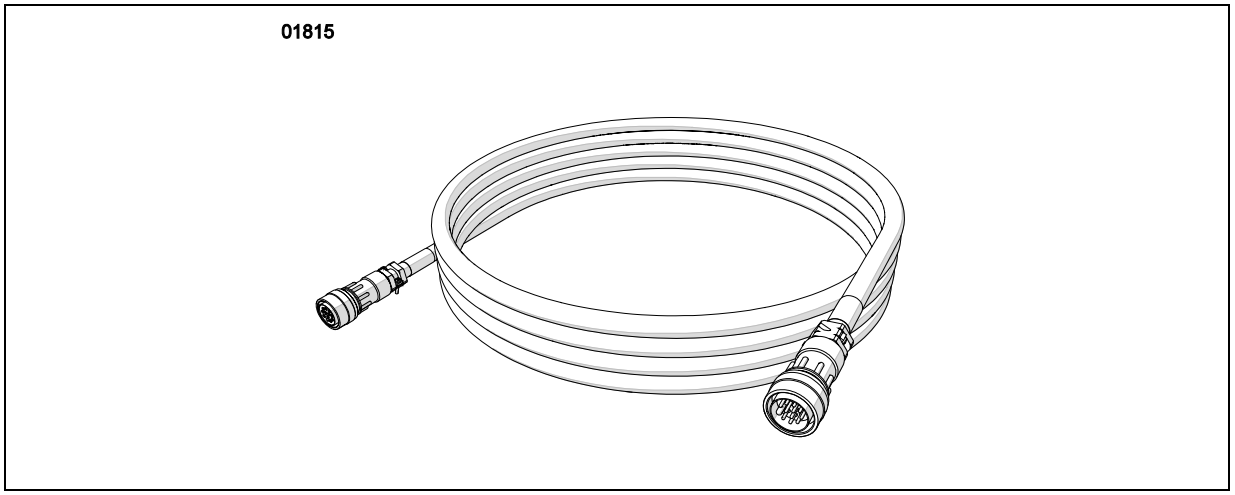


Figure 18: System Cables

Pre-terminated cables in various fixed lengths used to interconnect the control system modules.

Hydraulic System

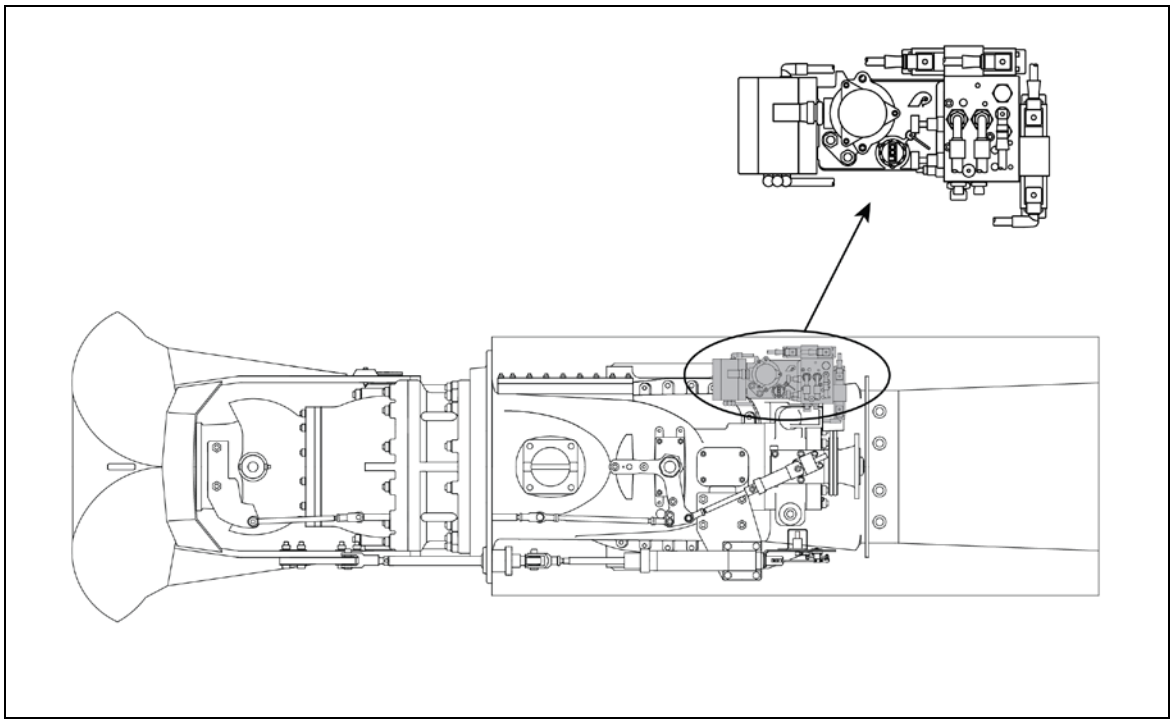


Figure 19: Jet Mounted Hydraulic Power Unit

Each Jet Unit is fitted with a Jet Mounted hydraulic power unit, (JHPU).

The JHPU provides hydraulic power to the Reverse Duct and Steering Nozzle cylinders. Each hydraulic cylinder is controlled electronically via solenoids and valves.

The Hydraulic System incorporates an oil cooler and filtration system.

2

3 - System Operation

In This Section

3

Overview

Do not run the Jet Unit out of the water unless it is fitted with a Dry Run Kit.

Before connecting or disconnecting any modules to the control system, ensure the Primary and Secondary power supplies are turned off.

Zero Speed

Refers to the ability of a Hamilton Jet water jet to achieve zero net thrust.

The effects of external forces such as water currents and wind will mean that the vessel may not necessarily hold position when the jet is in the *Zero Speed* position.

When two or more Jets are used, the thrust can also be adjusted with a helm or docking controller to achieve port or starboard thrust whilst the vessel has zero net ahead/astern thrust.

The Helm Wheel or Joystick modules control the jet nozzle providing vessel steering.

The Control Levers control the Reverse Duct and engine speed.

Four redundant control methods are provided to allow vessel control to be maintained.

- Normal controls.
- Backup controls.
- Manual operation following loss of electrical power.
- Manual operation following hydraulic failure.

3

Control Panel

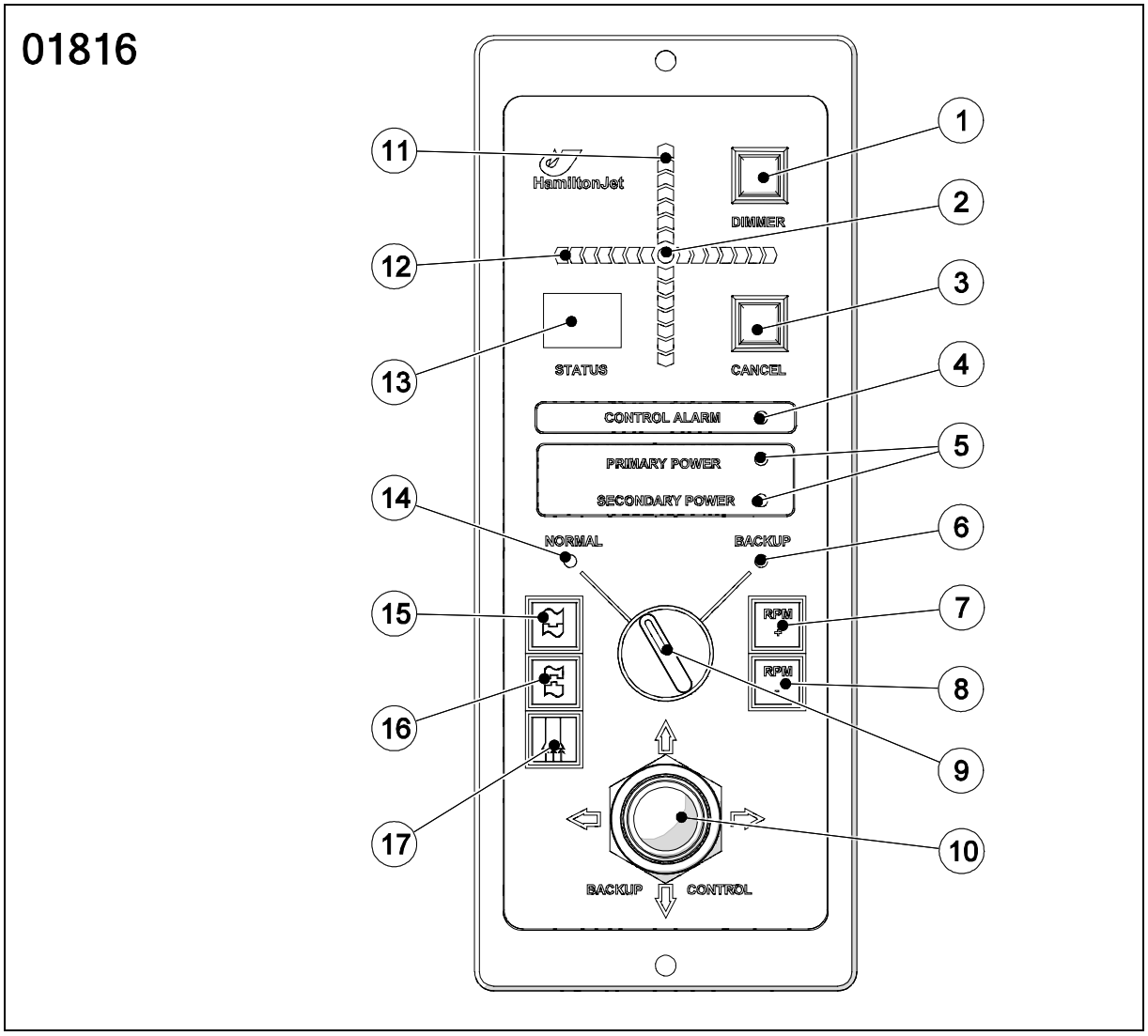


Figure 20: Control Panel Module layout

1	Lamp Dimmer	9	Normal/Backup Selector Switch
2	In Control Indicator	10	Backup Jog Stick
3	Alarm Cancel	11	Reverse Duct Position Indicator
4	Alarm Indicator	12	Steering Nozzle Position Indicator
5	Power Status Indicators	13	Status Indicator
6	Backup Mode Indicator	14	Normal Mode Indicator
7	RPM Increment	15	Drive Pushbutton and Indicator
8	RPM Decrement	16	Neutral Pushbutton and Indicator
		17	Backflush Pushbutton and Indicator

The Control Panel Module provides control of, and status information about the Jet Unit connected to that Control Panel.

Reverse Duct and Steering Nozzle Position Indicators

The vertical bar of the Reverse and Steering Position Indicator displays the Reverse Duct position.

The horizontal bar of the Reverse and Steering Position Indicator displays the Steering Nozzle position.

The centre Lamp in the steering and reverse indicator cross indicates if this Control Panel is *In control* of the vessel.

Status Indicator

The Status Indicator provides system information on:

Alarm codes.

- Set-up.
- Control transfer status.
- Forward or aft facing panel.
- Communications status.

Control Panel Module Status Codes

Status Code	Description	Refer
--	Throttle Synchronisation is currently enabled.	Refer: "Throttle Synchronisation" on Page 3-30
1P	Jet number 1 will not allow transfer of control.	Refer: "Control Transfer" on Page 3-25
2P	Jet number 2 will not allow transfer of control.	As above
3P	Jet number 3 will not allow transfer of control.	As above
4P	Jet number 4 will not allow transfer of control.	As above
5P	Jet number 5 will not allow transfer of control.	As above
AP	The autopilot is in control	Refer: "System Generated Faults" on Page 7-3
AO	The A.P.I. has detected a missing module.	As above
AA	The auto pilot auxiliary input is in use.	As above
Ac	There is a configuration error with the auto pilot.	As above
Ad	There is more than one auto pilot connected to this jet.	As above
AE	There is a memory error with the auto pilot interface.	As above
AF	The auto pilot interface is faulty (also used to show an aft facing panel on start up).	As above
AS	The auto pilot signal is out of range.	As above
At	The autopilot has a fault.	As above
A-	The autopilot has been turned off.	As above
bc	The jet is in 'Back-Up' control.	As above
bL	The jet bearing oil level is too low.	As above
bP	Bearing cooling pump pressure is low	As above
bt	The jet bearing is over heating.	As above
C1	Transfer has been made from the Secondary to the Primary Helm at the same Control Station.	Refer: "Control Transfer" on Page 3-25
C2	A transfer has been made from the Secondary to the Primary Helm at the same Control Station.	As above
Cn	There is a communications fault.	As above
d1	Communication with the Panel from Jet 1 has been lost.	As above
d2	Communication with the Panel from Jet 2 has been lost.	As above
d3	Communication with the Panel from Jet 3 has been lost.	As above
d4	Communication with the Panel from Jet 4 has been lost.	As above
d5	Communication with the Panel from Jet 5 has been lost.	As above
dF	A module is using factory default parameters.	As above

3

Status Code	Description	Refer
E0	The ECM. has detected a missing module.	As above
EA	External engine alarm.	As above
EC	There is a configuration error with the engine control module.	As above
Ed	There is more than 1 ECM connected to this jet.	As above
EE	There is a memory fault with the ECM.	As above
EF	The ECM is faulty.	As above
Eh	The engine is over heating.	As above
EL	The engine is in 'local' control.	Refer: "System Generated Faults" on Page 7-3
En	The engine is in manual control.	As above
Fd	Forward facing panel.	Refer: "Stage 2 - Connect Module Cables" on Page 6-3
9c	The gearbox has changed illegally.	Refer: "System Generated Faults" on Page 7-3
9F	The gearbox feedback has failed.	As above
9t	The gearbox has a fault.	As above
h-	Secondary helm mid helm parameter set-up.	Refer: "Panel Setup" on Page 6-17
h1	Secondary helm fault at control station 1.	Refer: "System Generated Faults" on Page 7-3
h2	Secondary helm fault at control station 2.	As above
h3	Secondary helm fault at control station 3	As above
h4	Secondary helm fault at control station 4	As above
h5	Secondary helm fault at control station 5	As above
h6	Secondary helm fault at control station 6	As above
H-	Primary helm mid helm parameter setup.	Refer: "Panel Setup" on Page 6-17
H1	Primary helm fault at control station 1.	Refer: "System Generated Faults" on Page 7-3
H2	Primary helm fault at control station 2.	As above
H3	Primary helm fault at control station 3.	As above
H4	Primary helm fault at control station 4.	As above
H5	Primary helm fault at control station 5.	As above
H6	Primary helm fault at control station 6.	As above
Hh	Steering type parameter set-up.	Refer: "Panel Setup" on Page 6-17
HC	Helm curve parameter set-up.	As above
HP	Full to port helm parameter set-up.	As above
Hr	The hand held remote safety switch is removed.	Refer: "System Generated Faults" on Page 7-3
HS	Full to starboard helm parameter set-up.	Refer: "Panel Setup" on Page 6-17
J0	A JCM has detected a missing module.	Refer: "System Generated Faults" on Page 7-3
J1	The primary power has failed.	As above

Status Code	Description	Refer
J2	The secondary power has failed.	As above
J4	There is a 'Back-Up' communication fault.	As above
JC	The jet configuration does not match that used on other jets.	As above
Jd	There is more than 1 JCM's attached to this jet.	As above
JE	The JCM has a memory fault.	As above
JF	The JCM has a fault.	As above
o 1,2,3,4,5	DCM1 (2, 3, 4, 5) X Signal missing or Out of Range	
	DCM1 (2, 3, 4, 5) Y Signal missing or Out of Range	
	DCM1 (2, 3, 4, 5) Z Signal missing or Out of Range	
	xDCM1 (2, 3, 4, 5) X Signal missing or Out of Range	
	xDCM1 (2, 3, 4, 5) Y Signal missing or Out of Range	
	xDCM1 (2, 3, 4, 5) Z Signal missing or Out of Range	
JL	Reverse duct lowering positioning fault.	As above
JP	Port steering positioning fault.	As above
Jr	Reverse duct feedback fault.	As above
JS	Starboard Steering positioning fault.	As above
Jt	Steering feedback fault.	As above
Ju	Reverse duct raising positioning fault.	As above
JU	An unknown module is connected.	As above
LC	Control Transfer is denied because the other station is locked.	Refer: "Control Transfer" on Page 3-25
nL	Number of Levers, panel parameter set-up.	Refer: "Panel Setup" on Page 6-17
O.1	Low hydraulic oil level.	Refer: "System Generated Faults" on Page 7-3
OP	Low hydraulic oil pressure.	As above
Ot	High hydraulic oil temperature.	As above
P0	The CPM. has detected a missing module.	As above
P4	'Back-Up' communications fault.	As above
Pc	Panel Control Conflict	As above
PC	Configuration error between two or more panels.	As above
Pd	There are two or more panels with the same jet and control station identification.	As above
PE	The panel has a memory fault.	As above
PF	The panel is faulty.	As above
P1	There is a Control mis-match.	The system will self correct
PY	The display circuit board in the module is faulty.	Refer: "System Generated Faults" on Page 7-3
r-	Primary helm fully ahead reverse lever parameter set-up.	Refer: "Panel Setup" on Page 6-17
r-	Either the primary helm reverse lever centre position parameter setup or an indication to move the control lever to zero speed position.	As above

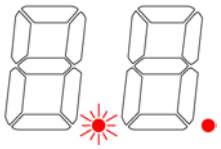
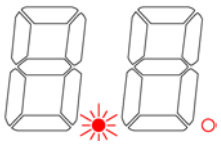
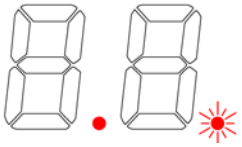
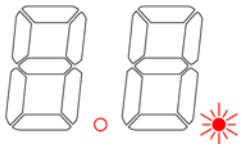
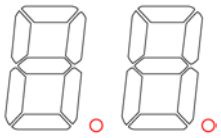
3

Status Code	Description	Refer
r.	Primary helm full astern reverse lever parameter set-up.	As above
r‾	Secondary helm full ahead reverse lever parameter set-up.	As above
r-	Either the secondary helm reverse lever centre position parameter setup or an indication to move the control lever to zero speed position.	As above
r_	Secondary helm full astern reverse lever parameter set-up.	As above
ro	Vessel has rolled passed the tilt switch limit	
rO	Jet Shaft Rpm is Out Of Range	
r 1	Primary helm reverse lever faulty at control station 1.	Refer: "System Generated Faults" on Page 7-3
r2	Primary helm reverse lever faulty at control station 2.	As above
r3	Primary helm reverse lever faulty at control station 3.	As above
r4	Primary helm reverse lever faulty at control station 4.	As above
r5	Primary helm reverse lever faulty at control station 5.	As above
r6	Primary helm reverse lever faulty at control station 6.	As above
r 1	Secondary helm reverse lever faulty at control station 1.	As above
r2	Secondary helm reverse lever faulty at control station 2.	As above
r3	Secondary helm reverse lever faulty at control station 3.	As above
r4	Secondary helm reverse lever faulty at control station 4.	As above
r5	Secondary helm reverse lever faulty at control station 5.	As above
r6	Secondary helm reverse lever faulty at control station 6.	As above
rP	The RPM feedback signal from the engine is faulty.	As above
S 1	The system is in 'simulate' mode.	As above
Sn	Jet junction box sensor supply failure.	As above
SP	Panel Module internal communications failure.	As above
SU	The panel is in Set-up Mode.	Refer: "Panel Setup" on Page 6-17
t 1	Throttle lever is faulty at control station 1.	Refer: "System Generated Faults" on Page 7-3
t2	Throttle lever is faulty at control station 2.	As above
t3	Throttle lever is faulty at control station 3.	As above
t4	Throttle lever is faulty at control station 4.	As above
t5	Throttle lever is faulty at control station 5.	As above
t6	Throttle lever is faulty at control station 6.	As above
t‾	Move the throttle lever to low idle / rpm.	Refer: "Starting the System" on Page 3-24
t-	Full ahead thrust lever parameter set-up.	Refer: "Panel Setup" on Page 6-17
t_	Idle thrust lever parameter set-up.	As above
tF	Control transfer is occurring.	Refer: "Control Transfer" on Page 3-25
UL	The Control Station is now unlocked and transfers to other stations are now allowed.	As above

Status Indicator Decimal Point

The communications status of the system is shown by the two decimal points at the bottom right of each character on the display.

The left hand decimal point represents *Normal* communication between modules. The right hand decimal point represents *Backup* communication.

Communication Status	Decimal Point
Normal communication is OK and in use. (Left Hand Decimal point flashing). *Backup* communication is OK and not in use. (Right Hand Decimal point on).	
Normal communication is OK and in use. (Left Hand Decimal point flashing). *Backup* communication is faulty (Right Hand Decimal point is off).	
Normal communication is OK and not in use. (Left Hand Decimal point on).' *Backup* communication is OK and in use. (Right Hand Decimal point flashing).	
Normal communication is faulty. (Left Hand Decimal point is off). *Backup* communication is OK and in use. (Right Hand Decimal point flashing).	
Normal communication is faulty. (Left Hand Decimal point is off). *Backup* communication is faulty (Right Hand Decimal point is off).	

Lamp Dimmer Pushbutton

The Lamp Dimmer Pushbutton dims the lamps on all the Control Panels at a control station.

- When the system is first switched on, the lamps are at full brightness.
- Each press of the dimmer button decreases the lamp brightness.
- When minimum brightness is reached the next press of the dimmer button restores the lamps to maximum brightness.

Alarm Cancel Push Button

The alarm Cancel has 2 functions, when pressed it:

- Acknowledges the current alarm or warning and stops the status indicator flashing and turns off the warning sounder.
- If the alarm condition is still present the alarm code will remain displayed on the status indicator.
- If the alarm condition no longer exists, the alarm code will be cleared from the status indicator.

Acts as a lamp test pushbutton:

- Tests all panel lamps, helm transfer lamp and warning sounder.

3

Alarm Indicator

The Alarm Indicator operates when there is a current jet control alarm or warning.

The status indicators on the control panel, and the JCM provide more information as to the cause of the alarm.

Warning Sounder

The warning sounder activates whenever a new alarm or warning is detected by the system.

Warnings cause a short beep. Alarms cause a continuous sound until acknowledged by pressing the Alarm Cancel button.

Power Supply Indicators

The Power Supply Indicators, remain permanently illuminated.

The Primary Power indicator displays the state of the main system power supply.

The Secondary Power indicator displays the state of the secondary or standby power supply.

If either supply fails or falls below the low voltage threshold the indicator will begin to flash.

Gearbox Indicator Buttons

To prevent damage to the Jet Hydraulic Pump Unit, backflush should not be operated for more than 30 seconds and the engine speed should be kept below 1000 rpm.

The illuminated Gearbox Push Buttons provide gearbox control. The button illuminates once the gear has engaged. All panels display the current gear even if the gear change originated from another panel.

Under *Normal* operation, gear changes may only be carried out from a Control Panel Module that is *In Control.*

Refer: "Control Transfer" on Page 3-25

In *Backup*, any Control Panel Module may be used to change gear.

Drive and *Backflush* can only be selected from *Neutral*. It is not possible to change to *Backflush* directly from *Drive* or vice versa.

The reverse lever must be set to *Zero Speed* and the throttle must be set to idle before a gear change can be made.

Refer: "Interlocks" on Page 3-23

Normal/Back-up Selector Switch

The Normal/Backup switch selects the operating mode of the related Jet Unit. It does not affect the operation of any other Jet Unit.

Normal Mode:

> *Normal* Operator Controls (Helm and Control Levers) are enabled, and the Backup Controls are disabled.

Backup Mode:

> *Backup* Operator Controls (Jogstick Control of Reverse and Steering) are enabled and Normal Controls are disabled. Throttle control is achieved by using the RPM Increment / Decrement push buttons on the Control Panel.

Normal / Back-up Indicators

The amber *Normal* Indicator shows the Local Control Panel is in *Normal* Mode.

The red *Backup* indicator shows the Jet control is in *Backup* Mode regardless of the state of the *Normal* Lamp.

It is possible for both the *Normal* and *Backup* indicators to be illuminated when the Control Panel is switched to Normal.

This could happen if the Jet Unit has been switched to *Backup* at another Control Panel or at the Jet Control Module.

RPM Increment / Decrement Push Buttons

In *Normal* mode these buttons allow the engine Idle RPM to be adjusted.

In *Backup* mode these buttons provide full engine throttle control.

RPM+ increases engine throttle. *RPM-* decreases engine throttle.

When both buttons are pressed for 1 second, throttle synchronization is enabled.

Refer: "Throttle Synchronisation" on Page 3-30

Back-up Jogstick Control

The *Backup* Jogstick operates when the controls are in *Backup* mode.

Moving the Jogstick forward or aft operates the Reverse Duct.

Moving the Jogstick Port or starboard operates the jet steering.

Steering and reverse cannot be operated at the same time.

Helm Wheel, Joystick and Tiller Modules

These steering modules provide jet steering during *Normal* control.

Steering modules contain an illuminated button used for transferring and locking control and providing control status indication.

Refer: "Control Transfer" on Page 3-25

Calibration of a steering module is carried out during CPM Set-Up.

In *Backup* mode the steering modules are disabled.

Refer: "Panel Setup" on Page 6-17

3

Control Lever Modules

Normal control of the Jet Unit Reverse Ducts and engine RPM is via either a Single Lever Controller (SLC) or separate Reverse and Throttle levers.

One set of control levers per control station is provided.

Only control levers at the station *In-Control* can be used at any time.

In *Backup* mode, the control levers are disabled.

Using the SLC:

- With both levers in their mid position the Jet Units give zero speed.
- Moving any lever forward increases the forward thrust on the corresponding Jet Unit.
- Moving any lever backwards increases the astern thrust on the corresponding Jet Unit.
- The overall effect of the SLC is that the further the lever is moved in a given direction, the faster the vessel travels in that direction.

Using separate levers:

- One lever operates the engine throttle, and one lever operates the Reverse Duct.

Zero speed does not mean no drive, water still passes through the Jet Unit.

The Reverse Duct deflects some of the jet stream forwards balancing forward and reverse thrusts giving no net vessel motion.

Hand Held Remote Control Module (HHR)

The hand held remote allows full *Normal* control in a single portable module.

The operator must hang the Hand Held Remote (HHR) from their neck, adjusting the neck strap so that two-handed operation is possible with the HHR resting against the body.

It is important that the wrist safety lanyard is worn during operation. The lanyard is connected to a safety switch which will cause an alarm if the HHR is dropped.

To meet Classification society Standards, the Wrist Lanyard must be Worn While the Hand Held Remote is in Control of the Vessel.

The HHR has a dial for steering control, and two levers, which operate as single lever control levers, one for the port Reverse Duct and Throttle and one for the starboard Reverse Duct and Throttle.

The transfer button allows the HHR to *Take Control* and to *Lock Control* as well as providing transfer status indication.

Calibration of the Hand Held Remote is carried out during CPM Set-Up.

Refer: "Panel Setup" on Page 6-17

In *Backup* mode the Hand Held Remote is disabled.

The Hand Held Remote is designed for low speed manoeuvring. It is not recommended for high-speed use or where there is a risk of the operator losing balance.

The Hand Held Remote should be used near ***Backup*** controls so that in the event of loss of ***Normal*** control, vessel operation can be maintained.

The safety wrist lanyard should always be worn during hand held remote operation.

Jet Control Module (JCM)

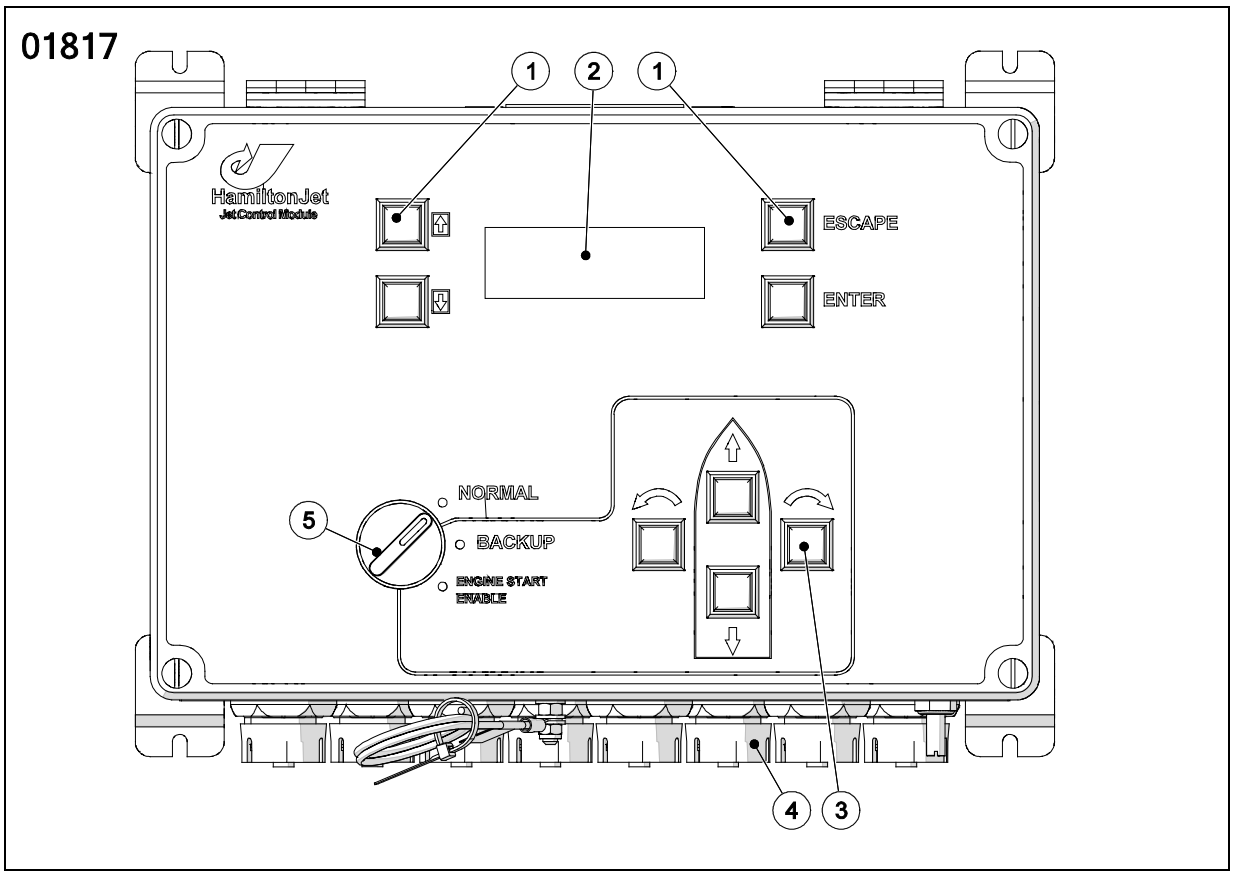


Figure 21: Jet Control Module

1 Programming Push Buttons
2 Display
3 Backup Control Push Buttons
4 Connectors
5 Control Mode Switch

The Jet Control Module uses a menu to provide alarm and system information.

The menu selection will automatically return to the Jet Data page if left for a period of time.

Navigation through the menu is by using the Programming pushbuttons.

The following is a description of the Operator Screens.

3

Main Menu Page

Press *ESCAPE* to bring up the **MAIN MENU** page.

From this page use the up and down arrow keys and press *ENTER* to make a selection.

Scroll the page to see more options.

```
=== Main Menu ===
   > Jet Data <
     Alarm Log
    System Data
```

Main Menu Items:

- Jet Data.
- Alarm Log.
- System Data.
- Jet Set-up (available only during the first 2 minutes after power-up).
- System Set-up (available only during the first 2 minutes after power -up).
- S/W Version.

Jet Data Page

The **Jet Data** page is displayed when the system is first switched on or may be accessed via the main menu as described previously.

```
      --- Jet Data ---
Mode: Normal-drive
Strg=28%S  Rev=24%F
Alarm: No Alarms
```

the second line displays the current mode, **Normal** or **Backup** and the present gear selection, **drive**, **neutral** or **bkFlush** (back flush).

The third line displays the position of the Steering Nozzle and Reverse Duct as percentages of the full movement Up / Down and Port / Starboard.

The bottom line displays the highest priority active alarm if there is one, otherwise it shows **No Alarms**. This matches the Alarm Code displayed at the Control Panels.

Press *ESCAPE* to return to the main menu.

Alarm Log Page

The **Alarm Log** page shows the history of alarms recorded by the JCM.

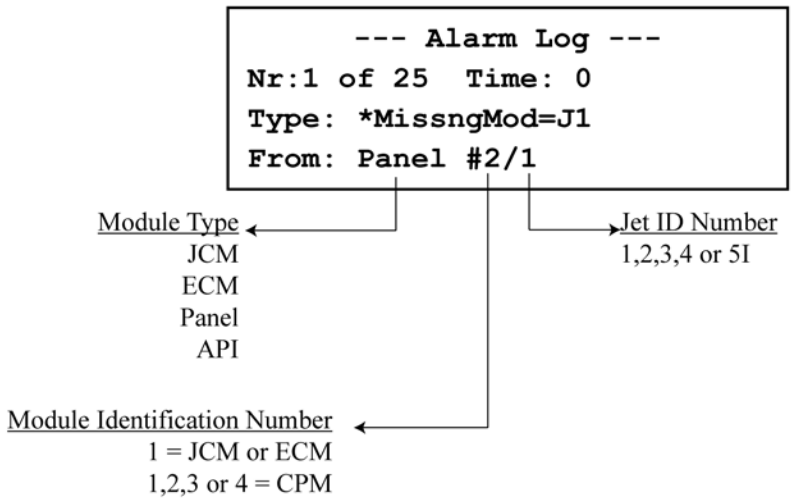
```
      --- Alarm Log ---
Nr:1 of 25  Time: 0
Type: *MissngMod=J1
From: Panel #2/1
```

The second line displays:

- The alarm number. Number 1 is the most recent alarm.
- The total number of alarms in the log.
- The number of times the system has being powered up since the alarm occurred
  - 0=current power up period
  - 1, 2, 3.....25=previous power up periods.

The third line displays the alarm type. This is a short description of the alarm. It is preceded by an asterisk if the alarm is currently active.

The last line shows the identity of the module, which detected the alarm.



Item	Description
1	* = Alarm Active No * Non Active Alarm
2	Alarm Code, Refer
3	Jet ID Number 1,2,3,4 or 5
4	Module identification number ▪ 1 = JCM or ECM ▪ 1,2,3 or 4 = CPM
5	Module Type ▪ JCM ▪ ECM ▪ CPM ▪ API ▪ DPI ▪ VDRI

For example:

Panel #2/1

Means the alarm was detected by Control Panel Module 2 of jet number 1.

Press the arrow keys, to see each entry in the alarm log.

Press *ENTER* to return to the latest alarm.

Press *ESCAPE* to return to the main menu.

System Data Page

```
--- System Data ---
Jet No.1of1  CtrlP=1
   Password: ,Xny
OilT=45C  OilP=13Bar
```

The **System Data** Page displays:

- The Jet Number.
- The Number of Jets.
- The control panel currently active.
- An encrypted version of the Set-Up password. If the password has been set and forgotten then contact CWF Hamilton & Co. Ltd. The encrypted password, can be used to determine the correct password.
- The hydraulic oil temperature in °C.
- The hydraulic oil pressure in Bar.

Press *ENTER* to update the temperature and pressure measurements.

Press *ESCAPE* to return to the main menu.

Jet Setup Page

This page can only be accessed during the first 2 minutes after switching the Power on.

```
Mode: SETUP
Password:0***
Adjust Value (↑&↓)
Ent=Next,   Esc=Quit
```

By entering the correct password it is possible to enter the Jet **SETUP** Menu.

The display will return to the Main Menu after a minute if no password is entered.

Press *ESCAPE* to return to the Main Menu.

System Setup Page

This page can only be accessed during the first 2 minutes after switching the power on.

```
Mode: SETUP (System)
Password:0***
Adjust Value (↑&↓)
Ent=Next,   Esc=Quit
```

By entering the correct password it is possible to enter the **SETUP (System)** menu.

The display will return to the Main Menu after a minute if no password is entered.

Press *ESCAPE* to return to the Main Menu.

Software Version Page

The **S/W Version** shows the version of JCM software and a copyright notice.

Press *ESCAPE* to return to the main menu.

Control Mode Switch

The JCM can switch to *Backup* control by using the Control Mode Selector Switch.

When in *Backup* the *Backup* push buttons are enabled.

Engine Start Enable overrides the engine start interlock, which normally prevents engine starting when the SLC / Throttle control lever is above the Zero Speed / Engine Idle position, or when the gearbox is not in neutral.

Backup Control Push Buttons

When in *Backup* mode, the *Backup* pushbuttons can be used to control the Jet Steering Nozzle and Reverse Duct.

Engine Control Module

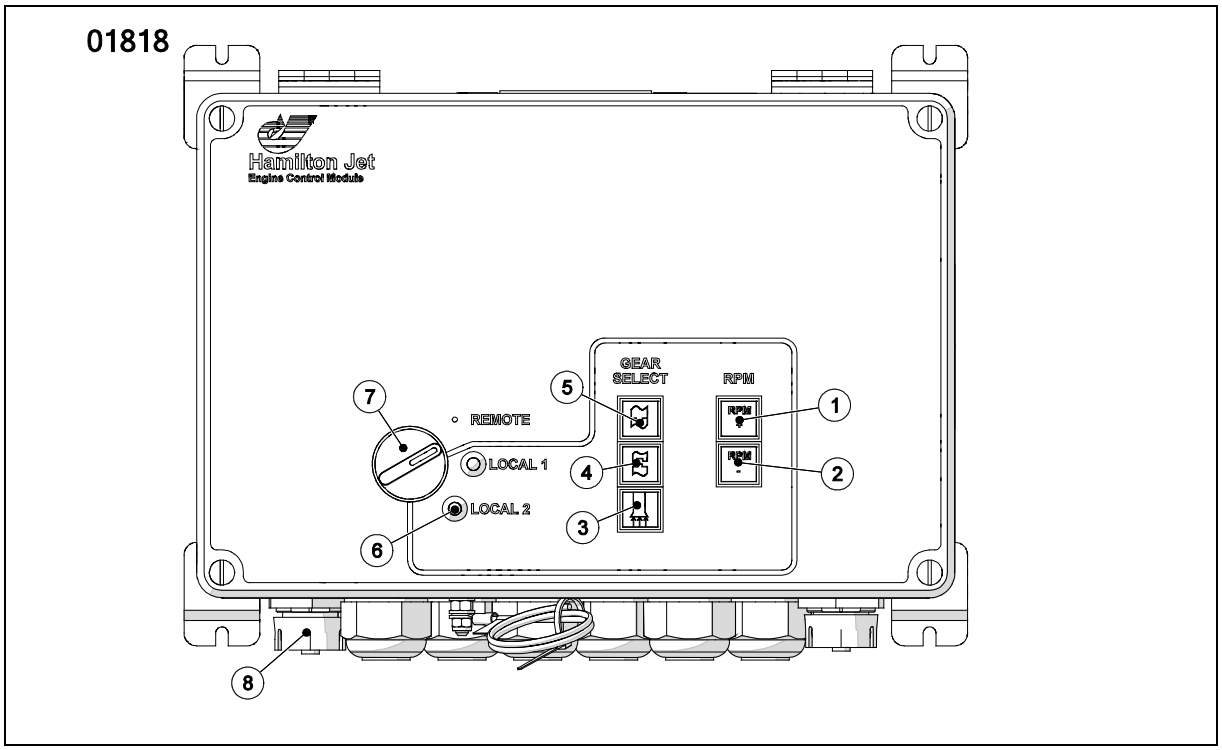


Figure 22: Engine Control Module

1	RPM Increment	5	Drive Pushbutton Indicator
2	RPM Decrement	6	Indicators
3	Backflush Pushbutton Indicator	7	Local/Remote Selector Switch
4	Neutral Pushbutton Indicator	8	Connectors

Remote Local Selector Switch

The Remote / Local Selector Switch allows control of the engine and gearbox either from the Control Panel Modules (Remote), or from the ECM mounted controls (Local 1 and Local 2).

Local 1:

- In *Local 1* mode both the gearbox and the engine throttle are controlled from the buttons on the front of the ECM. Operating the *RPM +* and *RPM -* buttons adjusts the primary throttle signal over the full operating range of the engine.

Local 2:

- This mode is the same as *Local 1* operation except that the *RPM +* and *RPM -* buttons operate the secondary throttle signal to the engine.

Gearbox Controls

The *GEAR SELECT* pushbuttons provide gearbox control when the ECM is switched to *Local 1* or *Local 2* mode.

The button lights up once the gear has engaged. All panels display the current gear.

Drive and *Backflush* can only be selected when the gear select is in *Neutral*. It is not possible to change to *Backflush* directly from *Drive* or vice versa.

The Reverse Lever must be set to *Zero Speed* and the throttle must be set to idle before a gear change can occur.

Refer: "Interlocks" on Page 3-23

Engine Control may be selected from the engine's local operator panel.

When the local operator panel is active, the engine RPM is set independently by the controls supplied with the engine.

This mode over-rides the setting on the selector switch on the ECM disabling the MECS engine controls.

To prevent damage to the Jet Hydraulic Pump Unit, backflush should not be operated for more than 30 seconds and the engine speed should be kept below 1000 rpm.

Lamp Test

To check all lamps on the ECM, press the *Neutral* button for 2 seconds.

Selector Switch position	MECS Mode	Active Engine Demand Signal	Active Engine Controls	Active Gearbox Controls
Local	x	x	Local operator panel	Local operator panel
Remote	Normal	Primary	Throttle or SLC lever and idle adjust buttons at station currently 'In Control'	Gearbox buttons on panel currently 'In Control'.
	Backup	Secondary	RPM+ and RPM- buttons at any station.	Gearbox buttons on any panel.
Local 1	x	Primary	RPM+ and RPM- buttons on the ECM.	Gearbox buttons on the ECM.
Local 2	x	Secondary	RPM+ and RPM- buttons on the ECM .	Gearbox buttons on the ECM.

Hand Held Remote Junction Box

The Hand Held Remote junction box allows the Hand Held Remote to be connected to the control panels.

Autopilot Interface Module (API)

The Autopilot Interface Module allows an autopilot to be connected to MECS.

Autopilot Operation

Make sure that the control station with the Autopilot, is in control of the vessel.

Switch the Autopilot to ***Auto ,*** the helm is now controlled by the autopilot.

- The helm wheel, joystick or tiller will be disabled.
- An **AP** status will display at all Control Panel Modules.

When the autopilot is switched to ***Manual*** mode, helm control automatically switches back to the helm wheel, joystick or tiller.

- An **A-** warning will display at all Control Panel Modules.
- Clear the warning by pressing the ***Cancel*** button.

The autopilot will immediately relinquish control of the helm if control station transfer occurs.

If control is transferred to a station with an operating Autopilot, the Autopilot will stop and must be switched OFF and then back ON again before it can operate.

If a Jet Unit is switched into ***Backup*** mode and then back to ***Normal*** Mode, the Autopilot will stop and must be switched to MANUAL and then back to AUTO before it can operate.

If the Autopilot Interface Module detects an internal fault, the throttle will be de-rated and the steering will stay in the position it was prior to the fault.

The Autopilot will resume control if the alarm condition has been removed and the SLC/Throttle Lever has been returned to the idle position.

If the vessel steering is under control of the autopilot (Autopilot in Auto mode, enabled) and the helm wheel (at the station that is in control) is moved beyond the setting of the CPM parameter ‘AP Override’, the autopilot interface will be disabled.

- An **A-** warning will display at all Control Panel Modules.
- Clear the warning by pressing the Cancel button.
- The Autopilot must be switched to manual and then back to Auto before it can operate.
- The **A-** warning will remain until the helm wheel is returned to the dead ahead position.

Jet Junction Box

The Jet Junction Box provides the connection point between the Control System and the Jet Unit.

Power and Interlock Module

The PIM provides:

- The jet power input point.
- An auxiliary power output.
- An alarm relay output.
- An engine start interlock relay.

Dynamic Positioning Interface Module

MECS is seen by the Dynamic Positioning System as an azimuth thruster that can be controlled to provide thrust in a specified direction or azimuth.

The azimuth and thrust signals are represented by voltages in the range -10 to +10V.

The DPI Module reads the azimuth and thrust signals and calculates the required water jet steering and reverse positions and the engine RPM.

The Steering, Reverse and RPM signals are then sent to the JCM and ECM.

The DPI Module converts Steering, Reverse and RPM feedback signals from the JCM and ECM.

These signals are sent to the DP system as azimuth and thrust feedback.

A DP mode switch tells MECS (and any other thrusters) when the DP system is controlling the vessel.

When this switch is in DP Mode, a 'DP_ENABLED' signal is sent to each DPI Module and the *Normal* MECS controls are disabled.

The DPI Module provides a *READY* signal (a relay contact) indicating to the DP system the status of each MECS jet system.

Bow Thrusters are connected directly with the DP system and not via MECS.

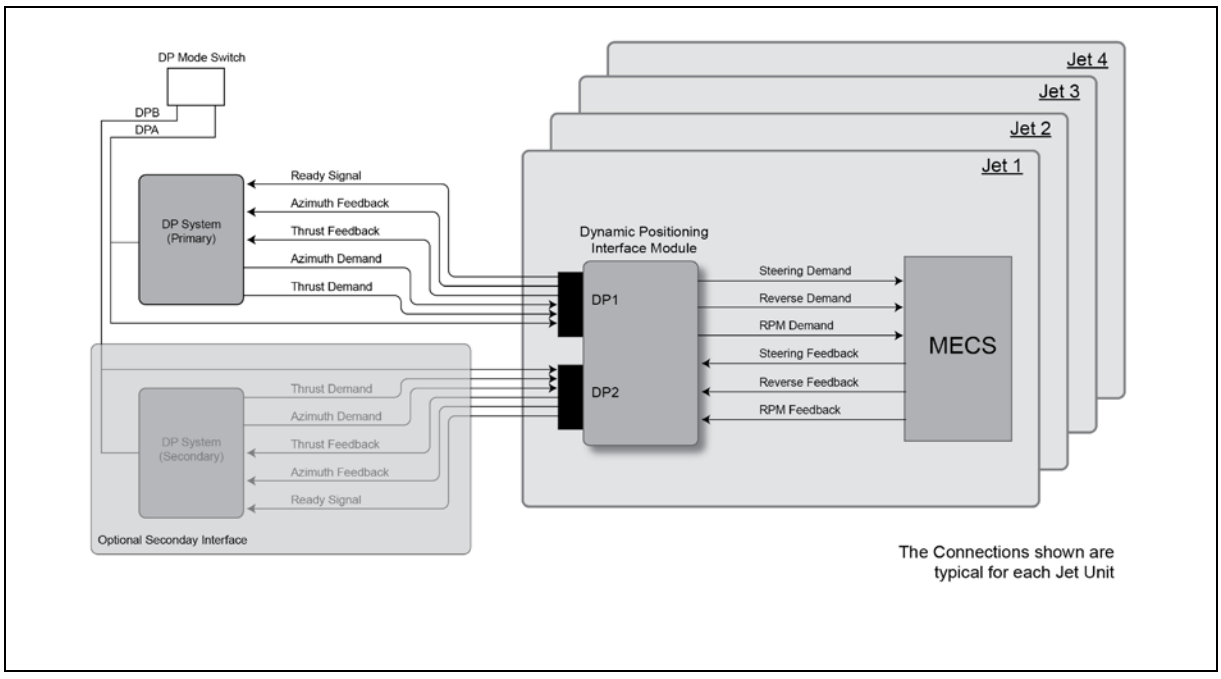


Figure 23: MECS Interface to Dynamic Positioning System

Hardware Description

The Dynamic Positioning Interface Module (DPI) provides the connection between the MECS Control Panels and the Dynamic Positioning System.

The DPI connects to MECS via a standard 'L' polarity cable.

The DPI connects to the Dynamic Positioning system via two 23-way connectors.

Cables are supplied to connect with Dynamic Positioning System.

These Cables have a plug on one end and are un-terminated at the other for connection to screw terminals at the Dynamic Positioning System.

3

DPI Signals

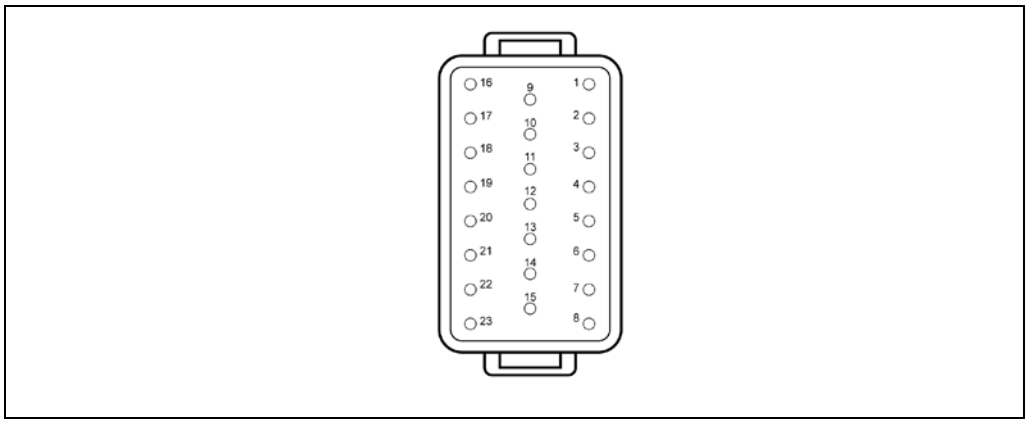


Figure 24: Rear View on DPI Connector

Cable to DPI System

Function	Signal	Direction	Connector Pin #	Cable Core #
Azimuth demand Analogue ground	Analogue -/+ 10V	Input	20 21	White 2 Black 2
Thrust demand Analogue ground	Analogue 0 - 10V	Input	22 23	White 3 Black 3
Azimuth feedback Analogue ground	Analogue -/+ 10V	Output	17 16	White 5 Black 5
Thrust feedback Analogue ground	Analogue 0 - 10V	Output	19 18	White 6 Black 6
'Ready' signal	Relay	Output	10 2	White 4 Black 4
'DP_Enabled' signal Digital ground	Digital	Input	14 7	White 1 Black 1

Cable to MECS System

Function	Signal	Direction	Connector Pin #
Cable screen			Pn-A
DPI +24V DPI -0V	Power Power	Input Input	Pn-B Pn-C
CAN bus Hi CAN bus lo CAN bus common	Network	I/O	Pn-D Pn-E Pn-F

DPI Operation

DP mode is selected via a Switch on the control console.

Before entering DP mode, make sure that:-

- All jet controls are in ***Normal*** mode.
- All gearboxes are in ***Drive.***
- There are no control system Alarms.

Jets that do not meet these conditions will not enter DP Mode.

Set the selector switch to either 'DPA' or 'DPB' to enter DP Mode.

To set a Jet in DP mode, quickly switch the Selector Switch to manual then back to DP.

A 0.5 second delay will prevent other jets already in DP mode from dropping out.

If during DP operation, a MECS alarm occurs preventing the Jet Unit from achieving the required azimuth and thrust, the jet mode changes to either ***DP Zero Speed*** or ***DP Gearbox Disengage*** and the ***Jet Ready*** status changes to ***FALSE*** (See state diagram).

The affected Jet Unit is set off line (it stops generating any thrust) and the DP system is told that this Jet Unit is unavailable.

When the fault is rectified, set the Jet Unit back into DP mode:

- Set the Normal/Backup Selector switch to ***Backup***
- Put the gearbox in Drive (if necessary)
- Set the Normal/Backup Selector switch to Normal
- Once the jet is back in DP Mode the ***Jet Ready*** status changes to ***TRUE***, indicating to the DP system that the Jet Unit is available.

To manually disable one or more Jet Units:

- Set the Normal/Backup Selector switch for the particular Jet Unit to ***Backup*** and put the gearbox in neutral.

Switching the selector switch from 'DPA' to 'DPB' or vice versa only changes the interface that the DPI uses. Operation will continue in DP mode.

The following diagram shows the modes that exist when:

- Switching between ***Manual*** and ***DP.***
- When alarms are activated.
- The Control System is switched in and out of ***Backup*** mode.

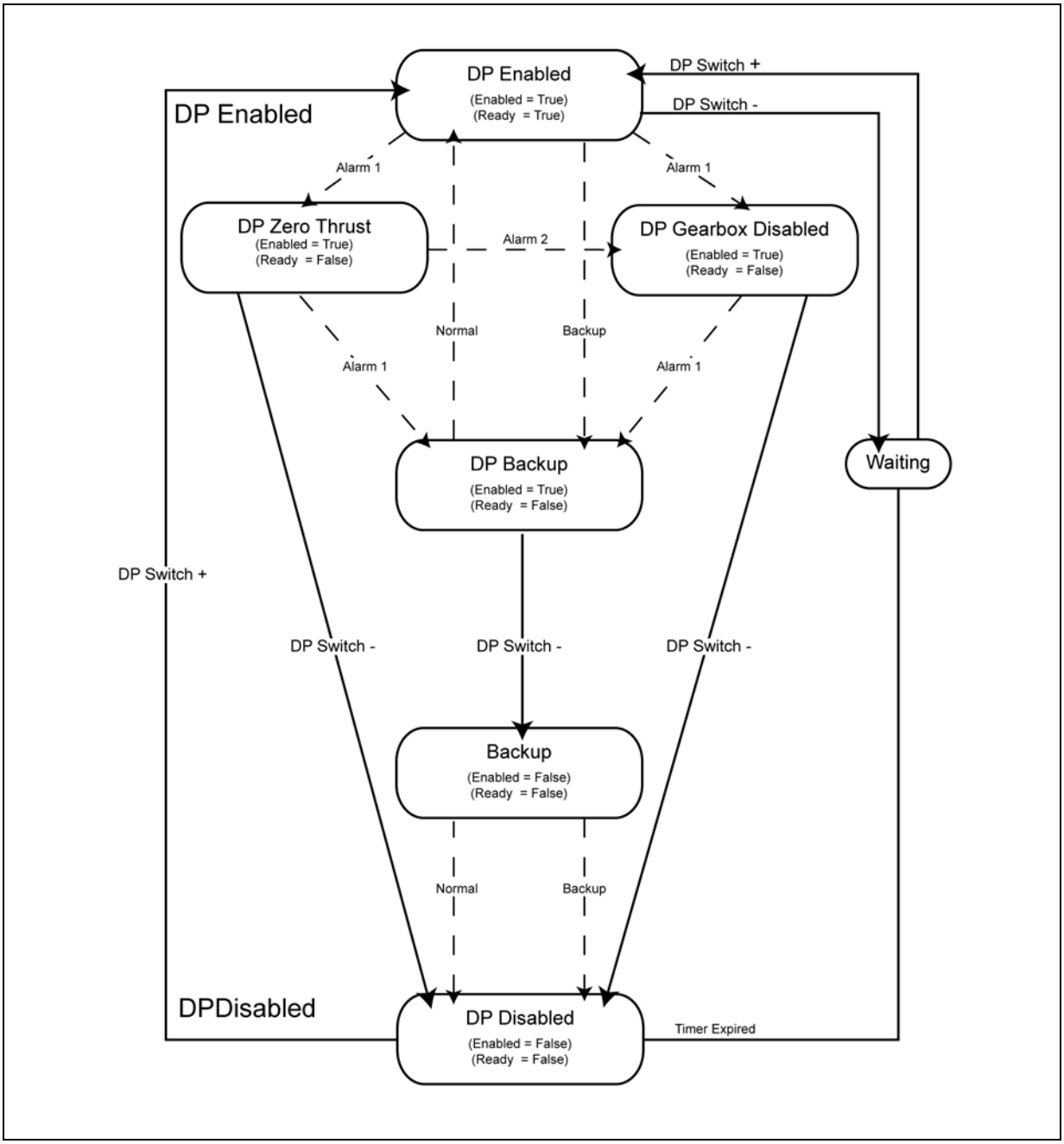


Figure 25: Dynamic Positioning Interface State Transition Diagram

DPI Status Codes

The following codes are shown on the Control Panel display to indicate Dynamic Positioning status.

These codes will be overwritten if a higher priority fault condition occurs.

The status codes are accompanied by an audible beep when they are first displayed.

Status Code	Description	Detail
dP	Dp modes enabled	Operating in DP mode and the jet is 'ready'.
do	DP mode, zero thrust	Occurs if a command value from the DP system is out of range. Jet steering is set to zero, reverse is set to zero speed and the throttle is low idle.
dn	DP mode, neutral	Occurs following a MECS alarm which prevents the DP azimuth and/or thrust commands from being executed. MECS attempts to set steering to zero, reverse to zero speed, the throttle to low idle then sets the gearbox to neutral.
db	DP mode, backup	The jet is in DP mode but is switched to backup and thus not under control of the DP system.
d-	Exiting from DP mode	Displayed momentarily when exiting from DP mode.
St	Wrong station for DP operation	The DP Selector Switch has been set to 'DP' mode but MECS is 'in-control' at a station that is not designated as the 'DP-station'. MECS remains in manual control mode.
9b	Cannot enter DP mode because gearbox not in drive, or gearbox being engaged	The DP Selector Switch has been set to 'DP' mode but the gearbox is not in Drive. MECS remains in manual control mode
9-	Gearbox being disengaged	Displayed momentarily when gearbox is being disengaged.
no	Cannot enter DP mode because of fault condition	The DP Selector Switch has been set to 'DP' mode but MECS cannot enter this mode because of a fault condition. MECS remains in manual control mode.

Interlocks

MECS provides a number of interlocks to prevent damage to equipment and to avoid dangerous operating situations.

Gear Change Rev Limit Interlock

Prevents the gearbox engaging or disengaging when the primary throttle demand signal is above idle.

Gear Change Sequence Interlock

Prevents gear changes directly between drive and backflush and vice versa, neutral must be selected first.

Gear Change / Reverse Demand Interlock

Prevents gear changes when the reverse lever is not in the zero speed position.

Engine Start Interlock

- Prevents the engine from starting when the gearbox is *In-Gear* or when the SLC / Throttle lever is not in the Zero Speed / engine idle position.
- For this interlock to operate, The ECM start interlock relay must be connected to the engine start inhibit input, or in series with the start signal (depending on engine type)
- In vessels without E.C.M's the Engine start interlock is available via the PIM.
- If the engine start signal requires more than 1Amp inductive load, an external interposing relay should be fitted.

The engine start interlock *must* be used on vessels without a clutch.

This interlock function may be provided by the engine control system, in which case the MECS engine start interlock should not be used.

Refer: "ECM Terminal Descriptions" on Page 6-4

Throttle / Reverse Interlock

Keeps the primary throttle signal at idle whenever the Reverse Duct is in the opposite position to the Reverse Lever.

i.e. When the Reverse Lever is in the ahead position and the Reverse Duct is down or vice versa.

For example, if the vessel is being operated in reverse and the SLC is moved to full ahead, the throttle will not increase until the Reverse Duct has risen past the zero speed position.

Trim Tab Control

Prevents the trim from operating until all Jets are in forward drive mode.

For this interlock to operate, the Trim Tab Control enable signal should be wired in series through each ECM's auxiliary relay.

Normal Operation

This Section explains how to operate a vessel using the MECS Control System.

Start-up

The System will always start with Control at the Station that was *In Control* when the system was last shut down.

The system will only start with a primary device in control.

Once the System has started, control may be transferred to another control station.

Initial Operations

- Ensure that the vessel is securely moored, or well clear of other objects.
- Set all Controls as follows:

Normal/Backup Selector Switch	Normal
Reverse Levers	Zero Speed
Throttle Levers	Idle
Helm	Centre Helm
Gearbox	Neutral

Starting the System

- Switch on the electric power to the engines and the Control System.
- Make sure that all Control Panel Modules are on and that both power lamps are illuminated at each panel.
- Transfer control to the desired station using the *Take Control* Button on the local helm.
- Use the *Alarm Cancel* pushbutton to cancel any alarms which may have occurred. Make sure that there are no current alarms.
- Test all indicator lamps and buzzers by pressing the *Alarm Cancel* pushbutton on each panel at each station.
- Start the engines.
- Put each Jet Unit into drive by selecting the *DRIVE* pushbutton on the Control Panel Modules.
- Make sure the Jet units respond to the operation of the Helm and Reverse Levers.
- Adjust the Reverse Levers and Helm Controls to prevent any vessel movement.
- Make sure that there are no current alarms.

Check operation of Back-up Control

Back-up mode must be checked every time the vessel is operated.

To check Back-up Operation:

- At any control station, switch one Jet into *BACKUP* Mode and make sure that the *BACKUP* Lamp illuminates and a **bc** status code is shown on the Control Panel Module display.
- Move the Backup Steering and Reverse Jogstick in each direction and using the Steering Nozzle and Reverse Duct Indicators, confirm that the correct movement occurs.
- Move the Backup Jogstick to the centre position returning the Steering Nozzle to Centre Helm and the Reverse Duct to Zero Speed.
- Adjust the engine RPM using the *RPM +* and *RPM -* buttons.
- Switch back to *Normal* Mode once correct operation of the *Backup* has been confirmed.
- Repeat the above for all Jets.
- Repeat the above for all Control Stations.

Prepare for Operation

To prevent damage to the Jet Hydraulic Pump Unit, backflush should not be operated for more than 30 seconds and the engine speed should be kept below 1000 rpm.

Clear out any debris by *Backflushing* each Jet Unit as follows:

- Make sure that the Reverse / Throttle Lever is set to Zero Speed.
- Make sure that the engine RPM is at Low Idle.
- Start Backflushing by pressing the *Backflush* pushbutton on the Control Panel Module.
- Backflush by increasing engine speed for a few seconds.
- Return to *Drive* via *Neutral*.

Normal Vessel operations can now commence.

Control Transfer

The transfer of control may be made:

- Between control stations.
- Between primary and secondary helms at the same station (Only in dual helm systems.).

During *Normal* operation only one control station or helm can be *In Control* at a time.

For smooth transfer of control, do the following:

- Set the Reverse and/or Throttle Levers to *Zero Speed* at the station taking control.
- Make sure that the Control Station currently *In Control* is not locked.
- Push the *Take Control* pushbutton on any primary control device at the Station taking control.
- Make sure that the *Take Control* button illuminates and flashes.
- A long beep will be heard from the station that has lost control.
- A short beep will be heard from the station that has taken control.
- Lock control at the panel by pressing the *Take Control* button again.
- The *Take Control* lamp will now illuminate continuously.
- Unlocked the control station by pressing the *Take Control* button again.
- A short beep will be heard when unlocking and a double beep will be heard when locking control stations. (Transfer Locking is only possible if this feature is enabled).

To transfer control to a Secondary Control Device:

- Make sure that the station with the secondary device is currently in control.
- Make sure that the secondary device is centred.
- Press the *Take Control* button on the secondary device.
- Make sure that the *Take Control* button illuminates and either remains steady or flashes.
- Two short beeps will be heard.

To Safely transfer control between primary and secondary control devices, transfer should be performed at zero speed

To transfer control to a Primary Control Device:

- Set the Reverse and/or Throttle Levers to the *Zero Speed* position.
- Press the *Take Control* button on the primary control device.
- Make sure that the *Take Control* button illuminates and either remains steady or flashes.
- One short beep will be heard.

Transfer Lamps on Control Devices	In Control Indicator on Control Panel	Meaning
On - Flashing	On	Station 'In control' and Unlocked
On - Steady	On	Station 'In control' and locked
Off	Off	Station not 'In control'

Control cannot be transferred if:-

- One of the Reverse / Throttle Levers, primary or secondary control devices at the station taking control is not in the *Zero Speed* position.
- There is an alarm on one of the panels at the station taking control.
- The station in control is locked.
- More than one JCM is not operational.
- The 'link' network connection to a JCM has failed.

Control Transfer Audible Alarms

Failed Attempt to Transfer

Sound from CPM requesting transfer	Beep type 0,	One long
	beep type 1 or 2,	One long
Sound from Other Station	Beep type 0,	None
	Beep type 1 or 2	None
Code on CPM requesting control	HP	Where X = the jet number not allowing a transfer. If the number is the same as the jet number of the panel then an alarm condition is present which will not allow a control transfer
Code on CPM at Other Station	No Change	

Failed Attempt to Transfer

Sound from CPM requesting transfer	Beep type 0,	One long
	beep type 1 or 2,	One long
Sound from Other Station	Beep type 0,	None
	Beep type 1 or 2	None
Code on CPM requesting control	r -	This panel has been sent a transfer request but the Reverse Lever connected to this panel is not in the Zero Speed position.
Code on CPM at Other Station	No Change	

Successful Transfer

Sound from CPM requesting transfer	Beep type 0,	One Short
	beep type 1 or 2,	Three Short
Sound from Other Station	Beep type 0,	One Long from station relinquishing control
	Beep type 1 or 2	One Long
Code on CPM requesting control	tF	A control transfer is occurring
Code on CPM at Other Station	No Change	

Lock Station

Sound from CPM requesting transfer	Beep type 0,	Two Very Short
	beep type 1 or 2,	Two Short
Sound from Other Station	Beep type 0,	None
	Beep type 1 or 2	None
Code on CPM requesting control	LC	A control transfer is not possible because another station is locked
Code on CPM at Other Station	No Change	

Unlock Station

Sound from CPM requesting transfer	Beep type 0,	One Short
	beep type 1 or 2,	Two Very Short
Sound from Other Station	Beep type 0,	None
	Beep type 1 or 2	None
Code on CPM requesting control	UL	The control station is unlocked
Code on CPM at Other Station	None	

Transfer requested from a station already in control

Sound from CPM requesting transfer	Beep type 0,	One Short
	beep type 1 or 2,	Two Short
Sound from Other Station	Beep type 0,	None
	Beep type 1 or 2	None
Code on CPM requesting control	UL LC	The station alternates between locked and unlocked as the button is pressed
Code on CPM at Other Station	None	

Transfer from primary helm to secondary helm at the same station

Sound from CPM requesting transfer	Beep type 0,	Two Short
	beep type 1 or 2,	Two Short
Sound from Other Station	Beep type 0,	None
	Beep type 1 or 2	None
Code on CPM requesting control	C2	
Code on CPM at Other Station	None	

Transfer from secondary helm to primary helm at the same station

Sound from CPM requesting transfer	Beep type 0,	One Short
	beep type 1 or 2,	One Short
Sound from Other Station	Beep type 0,	None
	Beep type 1 or 2	None
Code on CPM requesting control	C 1	
Code on CPM at Other Station	None	

Failed attempt to transfer to secondary device

Sound from CPM requesting transfer	Beep type 0,	None
	beep type 1 or 2,	None
Sound from Other Station	Beep type 0,	None
	Beep type 1 or 2	None
Code on CPM requesting control	no	
Code on CPM at Other Station	None	

Steering Operation

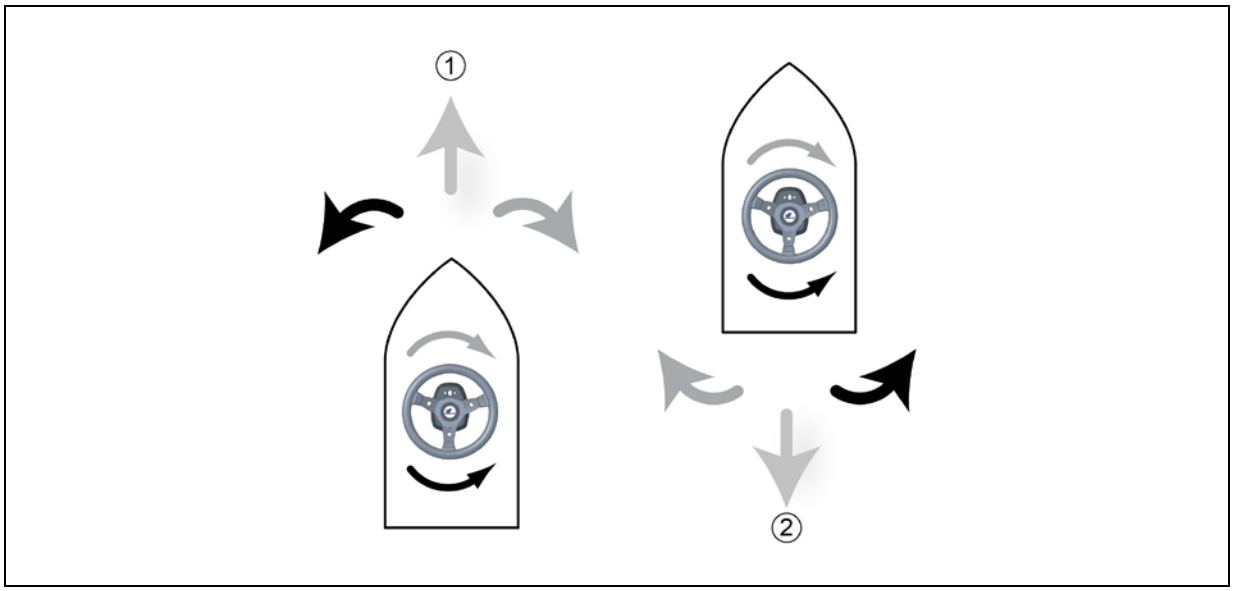


Figure 26: Steering Operation

1 Ahead
2 Astern

The Jet Unit Mainshaft must always be rotating whenever steering thrust is required.

The Steering Module controls the Jet Unit Steering Nozzle providing port and starboard steering.

If MECS detects a fault in the steering system, the throttle (if controlled by MECS) will be de-rated to idle and the steering will be kept its last position. To resume control in *Normal* mode, correct the fault and return the throttle lever to idle.

Note the following when operating a water jet propelled vessel:

- Larger thrusts selected on the control lever(s) result in larger steering effects and hence sharper turns.
- Steering is available at *ZERO SPEED* as well as all *AHEAD* and *ASTERN* thrusts.

Thrust Control

Jet Unit thrust is controlled by the position of the Reverse Duct and by the Engine RPM.

- Use the control lever(s) to adjust the astern / ahead thrust.
- Using higher Engine RPM will give greater manoeuvering force.
- With the Reverse / Throttle Lever fully forward, adjust Engine RPM to alter vessel speed under normal travel conditions (twin lever controls).
- The *Zero Speed* position is where the Jet Unit produces no nett forward or reverse force. The steering is still fully operational even when the vessel is stationary. This is not to be confused with the *Neutral* Gear position where no control is retained.
- High engine RPM while reversing is not recommended. This causes aerated water to be forced back into the Jet Unit Intake resulting in loss of efficiency.

Reducing the engine speed slows the vessel. It is not necessary to use Full Reverse to 'Brake' the vessel, except in emergency or manoeuvring situations.

If MECS detects a fault with the Reverse or Throttle, the Throttle (if controlled by MECS) will be set to idle and the Reverse Duct will stay at its current position.

To resume control in *Normal* mode, correct the fault and move the Throttle Lever back to the idle position.

Power Assisted Slowdown

This procedure should only be used in an emergency.

- Power assisted slowdown produces very rapid deceleration
- Power assisted slowdown should be used with care by new operators.
- Do not use full helm control until the vessel has slowed.
- Select zero speed as soon as the vessel has slowed

A fast slowdown can be achieved by lowering the Reverse Duct.

Unless there is an emergency situation, regulate the reverse thrust by either limiting the engine speed, or by limiting the movement of the Reverse Duct.

Throttle Synchronisation

Throttle synchronisation on multi-jet installations provides a single throttle signal to all engines.

To activate Throttle Synchronisation:

- Set all control levers to the same position.
- Set the Reverse Ducts to the fully raised position.
- Press the ***RPM+*** and ***RPM-*** buttons simultaneously for 1 second on the Control Panel nearest to port.

Once throttle synchronisation is active, '**--**' is displayed on the Control Panel Module.

To keep throttle synchronisation, move the control levers together, keeping them approximately in the same position.

To turning off Throttle Synchronisation either:

- Press the ***RPM+*** and ***RPM-*** buttons simultaneously for 1 second on the Control Panel nearest to port.
- Move a Control Lever more than 20% away from any other Control Lever.
- Lower a Reverse Duct.
- Switching any jet into ***Backup*** mode.

Low Speed Manoeuvring

Full steering thrust is available at all positions of the Reverse Lever, including the ***Zero Speed*** position

Engine Speed Adjustment

Engine speed should be set to idle.

Use the ***RPM+*** and ***RPM-***buttons on a CPM to adjust the engine idle speed to suit wind and current conditions.

Vessel Rotation

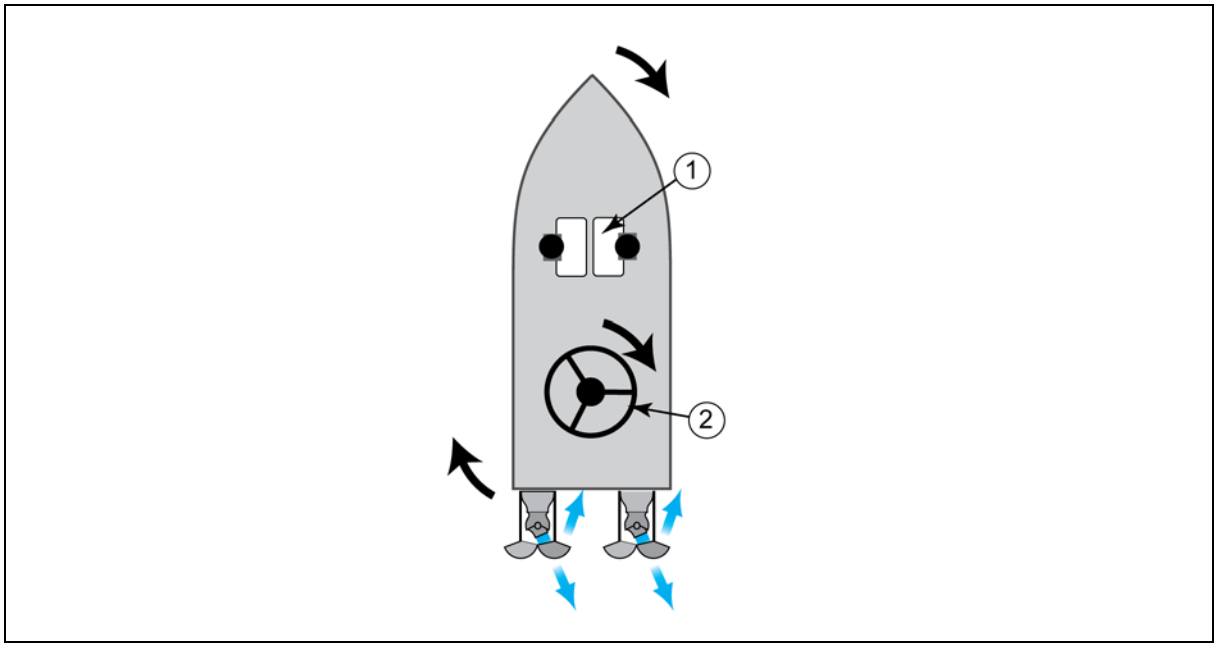


Figure 27: Vessel Rotation

1 Dual Single Lever Controller set to Zero Speed
2 Helm Wheel

- Set the Control Lever(s) to zero speed.
- Rotate the vessel using the Helm Control. The vessel will rotate on the spot.
- To stop vessel rotation, apply opposite steering.
- Once the manoeuvre is complete, centre the Helm Controls.

Moving Sideways

With Twin Jets

The following procedure moves the vessel to port. To move to starboard just transpose port and starboard.

Set both Reverse Control Levers to zero Speed and make sure the vessel is stationary.

Set both engine RPM's to just above idle with slightly higher RPM on the port side.

1 Set steering to ahead.
2 Move the port reverse control lever to full astern and the starboard lever to full ahead. This will cause the bow of the vessel to swing to port.
3 Turn the helm to starboard to counteract the port rotation of the vessel.

The vessel will now move sideways to Port.

Adjust the port engine RPM or bring the starboard reverse control lever back to the zero speed position to prevent fore and aft movement. (Higher RPM moves vessel aft).

When the vessel is positioned correctly, move both reverse control levers back to zero speed and centre the helm.

To Stop Sideways Movement

- Set the Steering to dead ahead, Throttle RPM to idle and Reverse to Zero Speed before the vessel reaches the required position.
- Alternatively set the Controls to start sideways movement in the opposite direction until the vessel stops sideways movement then set the Steering to dead ahead, Throttle RPM to idle and Reverse to Zero Speed.

Manoeuvring Joystick Module

The Manoeuvring Joystick Module is a 3 axis joystick controlling forward, aft, port, starboard and rotational movement of the vessel. It is mainly is used for low speed Manoeuvres.

- Moving the Joystick will cause the vessel to move in that direction.
- Twisting the Joystick Knob will cause the vessel to rotate.
- Centering the Joystick returns the vessel to ***Zero Speed.***
- Initial Joystick Movement controls the Reverse Duct position.
- Further Joystick Movement Controls the throttle. if more engine RPM is required then the Single Lever Controllers can be used.
- The helm is disabled when the MJM is in control.
- If the vessel starts to rotate due to the effects of wind or tide, turn the Joystick knob slightly in the opposite direction to counteract the rotation.
- In ***Backup*** mode the MJM is disabled.
- If ***Backup*** mode is entered while manoeuvring, all Reverse Ducts should be returned to ***Zero Speed*** before proceeding.

Shut Down

- Make sure that the vessel is securely moored.
- Centralise the Steering Nozzles and make sure all Reverse Levers are in the ***Zero Speed*** position.
- Disengage all Jet Units by pressing the ***NEUTRAL*** Pushbutton on the Gearbox Control Panels.
- Shutdown all Engines.
- Switch off electrical power to the Control System.

Back-up Operation

Back-up mode must be checked every time the vessel is operated.

To operate a Jet Unit in ***Backup*** mode, switch the Normal/Backup selector switch on the corresponding Control Panel Module or Jet Control Module into ***Backup***.

Backup control is not intended for everyday use. It is provided as a means of controlling the Jet if ***Normal*** mode fails.

Any Normal Control fault must be corrected as soon as possible.

Once the vessel has returned to port, continued operation in ***Backup*** mode is subject to the vessel master being satisfied that the vessel can be satisfactorily controlled in ***Backup.*** This includes consideration of the helmsman's familiarity with ***Backup*** operation.

Back-up Control at the Control Panel

The Jogstick on the Control Panel or the ***Backup*** pushbuttons on the Jet Control Module are used to control the Jet Unit in ***Backup*** Mode.

These controls are only active when the Jet Unit is in the ***Backup*** Mode.

The Jogstick or pushbuttons operate the Reverse Duct or Steering Nozzle, for that Jet Unit only, in a simple Stop / Start manner.

The Steering / Reverse Indicators show the position of the Reverse Duct or Steering Nozzle during ***Backup*** Operation.

The Steering Nozzle and Reverse Duct cannot be controlled at the same time.

To use Back-up Control

- Set the Normal/Backup Selector Switch to ***Backup***.
- The ***Backup*** Mode Indicator should illuminate on the Control Panel Module.
- A ***Backup** alarm will display at the Jet Control Module.
- Push the Jogstick or pushbuttons to move the Steering Nozzle or Reverse Duct.
- Hold the ***Backup*** controls until the steering or reverse duct reaches the desired position.
- The ***RPM+*** and ***RPM-*** pushbuttons on the CPM or ECM control the throttle. Use these buttons to increase or decrease the engine speed as required.

3

Abnormal Operation

In cases of electrical or hydraulic failure, some control of the vessel will still be possible

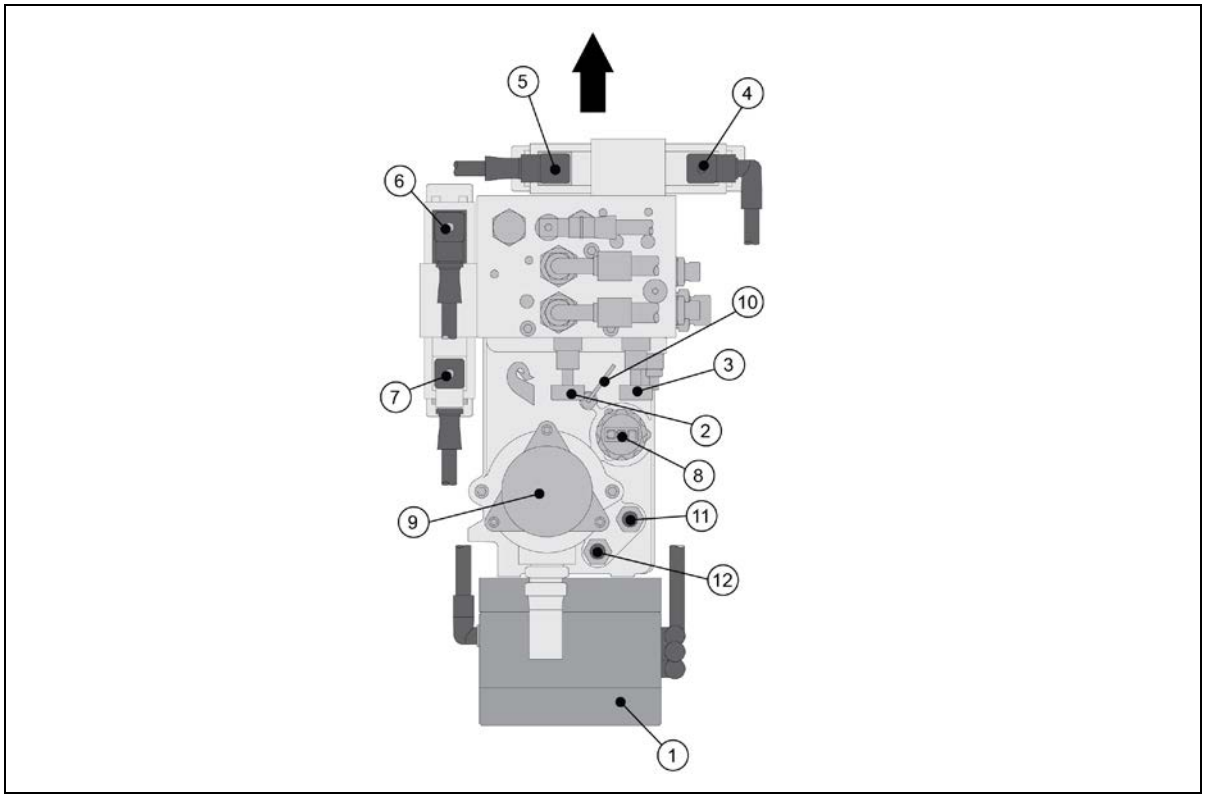


Figure 28: Jet Mounted Hydraulic Power Unit

1	Jet Junction Box	7	Astern Proportional Valve
2	Reverse By-pass Valve	8	Breather Filler Cap
3	Steering By-pass Valve	9	Filter
4	Starboard Proportional Valve	10	Dip Stick
5	Port Proportional Valve	11	Temperature Sensor
6	Ahead Proportional Valve	12	Level Sensor

Failure of Electrical Power

In the unlikely event of electrical power failure, hydraulic power will still be available as long as the Mainshaft is turning.

The proportional valves can be operated locally by manually moving the valve spool.

This is done by inserting an Allen key or screw driver [A] into the end of the solenoid valve.

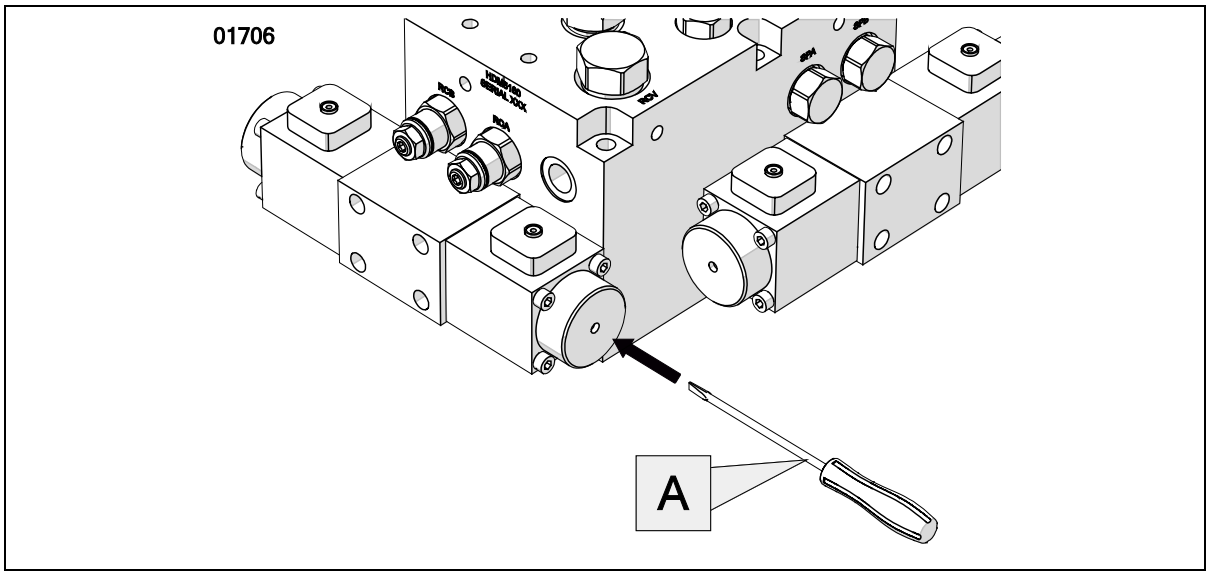


Figure 29: Manual Control of the Proportional Valve

Manual Control of Steering Nozzle and Reverse Duct

In the unlikely event of a complete hydraulic power failure, a degree of control over the vessel will be possible by manually moving the Steering Tiller or using a rope to lift the Reverse Duct as described below.

If applicable, switch any control system into backup mode.

Emergency Manual Steering Control:

- Open the steering by-pass valve on the jet hydraulic power unit, or disconnect the hydraulic hoses at the steering cylinder.
- Use the Emergency Tiller Extension Lever (or a suitable pipe or lever) to manually move the steering mechanism inside the boat.
- If necessary, lock the steering in position by closing the Bypass valve.
- A preferred method of control in Multi Jet vessels is to shut down the failed Jet Unit (with the Reverse Duct raised) and continue using the other Jet Units.

Manual steering is only possible at low RPM

Emergency Manual Reverse Duct Control:

- Attach a rope to the external reverse duct lifting eye (if Present) or around the reverse duct.
- Take the weight of the reverse duct on the rope.
- Open the reverse by-pass valve on the jet hydraulic power or disconnect the hoses to the Reverse Cylinder.
- Lift or lower the reverse duct as required.
- Lock the Reverse duct into position by closing the Bypass Valve.

Closing the by-pass valves will lock the steering and reverse cylinders only if the hydraulic circuit is undamaged.

3

4 - Design Basics

In This Section

4

Selection Guidelines for MECS Control Systems

Use the following guidelines when selecting a MECS control system.

Quantity and Location of Control Stations

Each control station (for a twin jet system) typically adds four modules and eight cables to the overall system.

While it is normal for a vessel to have a main control station situated on the bridge, the need for other control stations will vary depending on the designed use of the vessel.

For example:

- Oil rig support vessels require control stations located so that the operator can see the deck during loading / unloading.
- Pilot Vessels require control stations located so that the operator can see pilots boarding other vessels.
- Fishing Vessels require control stations located on a fly bridge to allow 360° visibility.

When determining control station locations, consideration should be given to the Hand Held Remote Control Unit. The Hand Held Remote lets operators move freely around the vessel eliminating the need for extra control stations.

Bridge Control Options

MECS provides four different methods of helm control:

- Helm Wheel.
- Joystick.
- Tiller.
- Hand Held Remote Control.

Considerations when selecting a steering module:

- The size and location of the steering module.

  The helm wheel module is larger than the other steering modules.

  Can be mounted vertically and so may be mounted in an area that does not conflict with other bridge-mounted controls.
- The sensitivity of the steering module.

  A helm wheel module is less sensitive than the other Helm modules. This can be beneficial when operating in rough seas.

  The extra sensitivity of the other modules can be beneficial in calm water and tight manoeuvring situations.
- Familiarity.

  If operators are familiar with tiller operation, a new vessel with a tiller helm avoids the need to learn new controls.

Helm Wheel

The Helm Wheel Module can be supplied with a variety of wheel size options.

- 12-inch padded wheel.
- 16, 18, 20, 22 or 24 inch destroyer style wheels.

Joystick

The Joystick Module can be supplied with either:

- Spring Return:

  Allows the joystick to return to the centre helm position.
- Friction Lock:

  Allows the joystick to remain in its selected position.

Tiller

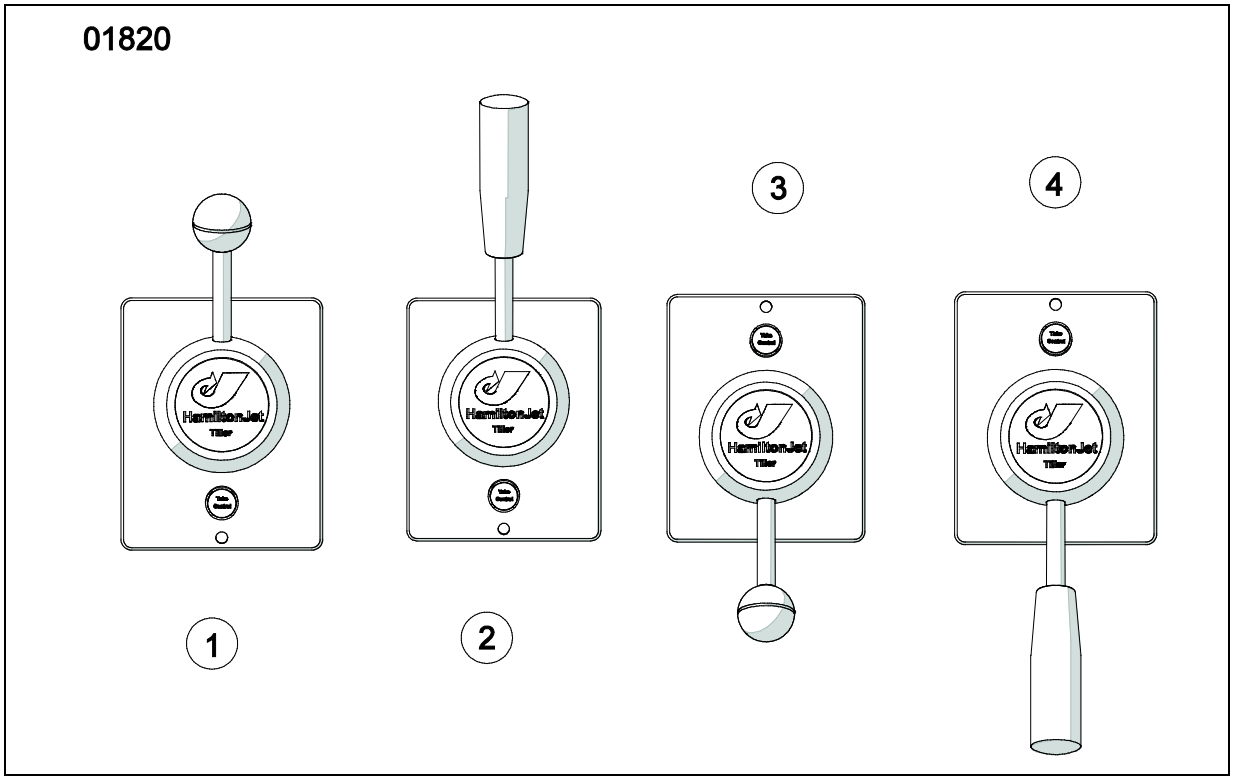


Figure 30: Tiller Options

1 Long Handle Forward Facing
2 Short Handle Forward Facing
3 Long Handle Rear Facing
4 Short Handle Rear Facing

The Tiller Module can be supplied with either:

- A long tapered handle (4 inch).
- Short ball style handle.
- Forward facing.
- Rear facing.

Primary and Secondary Controls

Normal control at any Control Station may be either a primary or secondary device.

There must always be a primary device at a Control Station.

Transfer between Control Stations is always to the primary device.

The secondary device is optional and may not operate exactly the same as the Primary device.

The Secondary device:

- Cannot take control from another Control Station.
- Can take control from a Primary device at the same Control Station.
- Can lock the station but the Primary device at the same Control Station can unlock the station.

4

The following table lists the valid control options:

		Secondary Controls			
		None	Helm, Steering Joystick or Tiller	Maneuvering Joystick	Handheld Remote Control
Primary Controls	None	Not an option	Not an option	Not an option	Not an option
	Helm, Steering Joystick or Tiller and Single Lever Controller	OK	OK	OK	Not an option
	Helm, Steering Joystick or Tiller and Throttle and Reverse Levers	OK	OK	Not an option	Not an option
	Handheld Remote Control	OK	Not an option	Not an option	Not an option

Control Levers

Control Levers are used to control the Reverse Duct and Throttle.

Individual levers can be used for throttle and revere Control.

Having individual levers gives increased control, but it becomes difficult to manipulate the Throttles and Reverse with one hand whilst trying to operate the Helm with the other.

Alternatively throttle and reverse functions can be combined on the one lever (Single Lever Control (SLC)).

SLC allows single handed control of the vessel, however, when the Reverse Ducts are in the down position, throttle control is limited to the *RPM+* and *RPM-* buttons on the Control Panel Modules.

The levers on the Hand Held Remote operate in SLC mode.

Autopilot

If an Autopilot is used, an Autopilot Interface Module is required.

5 - Installation

In This Section

Before connecting or disconnecting any modules to the control system, ensure the Primary and Secondary power supplies are turned off.

Arc Welding

Note the following when welding:

- If welding is to be closer than 1 metre from any modules or cable, the module or cables must be removed.
- The Control System must be switched off during arc welding.

Always use short earthing cables to earth the arc welding operation locally.

It is important that there is a low impedance earth bond from the module to the ships hull or earth bonding system for RFI and EMI compliance. A Value of 1Ω or less is ideal.

The Control Modules are fitted with an earth strap which must be bonded to the vessel structure (if metal) or earth bonding system using a spring or star washer to ensure a reliable connection

Precautions against Corrosion

If corrosion becomes a problem, take the following precautions.

- Liberally grease Rod Ends and Linkages with water resistant grease.
- Wrap Anti Corrosion Tape (eg. Nippon Denso) around the hydraulic fittings.
- Protect the MECS modules and connectors from contact with water and waterspray, especially saltwater by using appropriate shields or covers.
- Do not allow water to sit on the MECS Modules and connectors.

Location and Protection of Control Equipment

Before unpacking, determine the module locations and prepare all mountings.

This will:

- Reduce the chances of damage to equipment.
- Allow cabling routes and lengths to be determined early.

The following Sections give recommendations on control equipment installation.

Bridge Mounted Control Modules

Bridge Mounted Modules:

- Can be mounted into consoles with a thickness of between 2 - 30mm.
- Should be mounted away from direct sunlight. This will improve daytime visibility.
- Should be mounted so as to avoid reflections of the lamps in the bridge windows. This will reduce distractions.
- Make sure there is sufficient clearance beneath the modules to attach interconnecting cables.

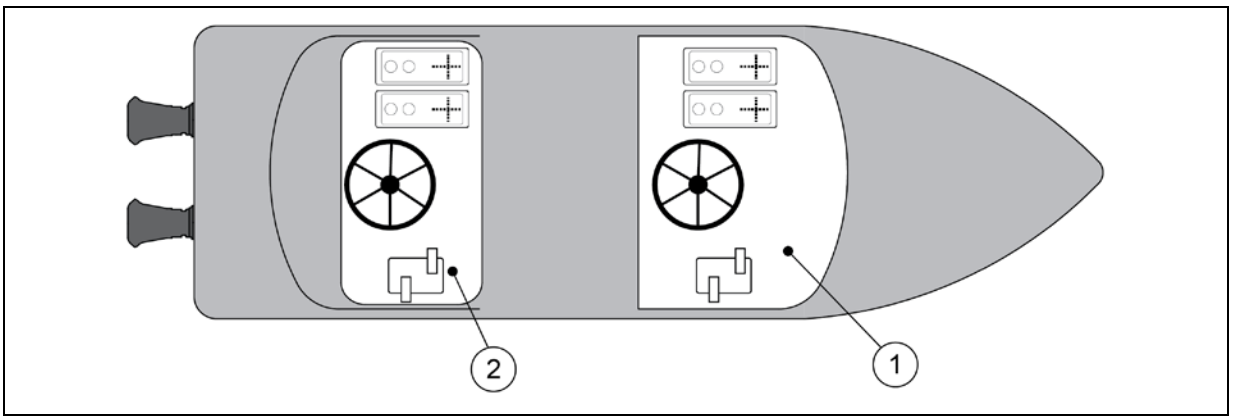
Cables should never be bent to a small radius. The prescribed minimums on the Dimension drawings should be considered the exception rather than the rule and the actual bending radius should be the largest which circumstances will permit.

- Make sure the Levers, Helm wheel or Joystick have enough room to be easily operated.

Location and Protection of operator Controls

Recommended mounting of Operator Control Equipment.

- A rigid protective housing should be used to enclose exposed Control Panels.
- Reflections of the Control Panel lamps in the bridge windows should be avoided.
- Daylight visibility will be improved if Control Panels are mounted away from direct sunlight and inclined at an angle.
- The diagram below shows a Twin Jet Monohull installation, but module locations are applicable to all installation types.



1 Control Station 1 (Bridge Mounted)

Requirements for bridge mounted control stations:

- Seal all panels to console.

2 Control Station 2 (Deck Mounted)

Requirements for deck mounted control stations:

- Consoles should be sealed from water ingress.
- Seal all panels to console.
- Do not fit drain holes in consoles to the open deck.
- Spray all electrical connections with electrical quality silicone sealant.
- Fit sealed removable covers to all open deck equipment.

A terminating link ***MUST*** be fitted to both the R1 & Nx connectors of the last Control Panel Module in the chain.

Failure to do so will force the control system into Backup mode.

Engine Room Mounted Control Modules

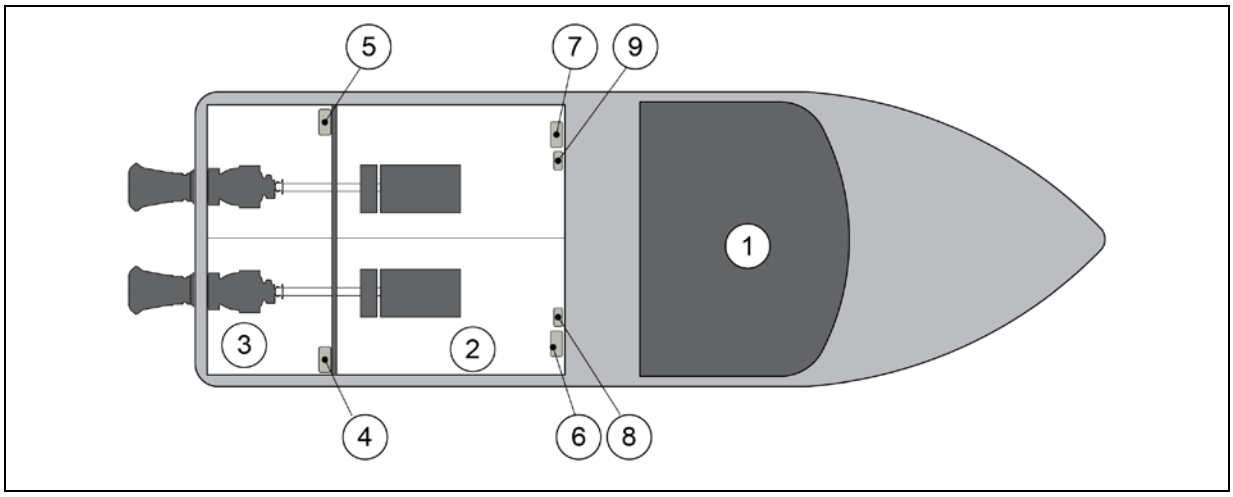
The Propulsion Control Module should be mounted:

- Upright on a bulkhead close to its respective engine.
- Away from high vibration areas, or rubber mounts (not provided) should be used to reduce vibration
- In an easily accessible location.

Location of Modules

Recommended mounting of Jet Control Modules, Engine Control Modules and Power and Interlock Modules.

- Make sure that these modules are easily accessible for Control System setup and local control of the Jet Units.
- The Jet Units should be visible from the Jet Control Module.
- The diagram below shows a Twin Jet Monohull installation, but module locations are applicable to all installation types.



1 Bridge
2 Engine Compartment
3 Jet Unit Compartment
4 Jet Control Module (Starboard)
5 Jet Control Module (Port)
6 Engine Control Module (Starboard)
7 Engine Control Module (Port)
8 Power and Interlock Module (Starboard)
9 Power and Interlock Module (Port)

Environmental Requirements for MECS Modules

Temperature:

The Electronic Modules have an operating temperature range of 5deg C to 55deg C.

Condensation:

Modules are fitted with Silica Gel packs to prevent Condensation.

Do not open any of the modules, except the PIM and ECM

Only open Modules when required, and for the minimum period of time.

Modules contain no user serviceable parts.

Vibration:

The modules should not be exposed to high levels of vibration.

In vessels with 'hard' mounted engines, modules located in the engine room should be fitted with anti-vibration mounts (Not part of CWF Hamilton supply).

5

Determining Cable Lengths

Connections between Control modules, are made using pre-assembled cables.

Cable lengths must be determined early and supplied to C.W.F.Hamilton Ltd to allow cable assemblies to be manufactured.

Note the following when determining cable routes and lengths.

- Cables should be fitted inside open top trays or enclosed ducts.
- Cable trays and / or ducts should provide protection against oil, dirt and mechanical damage.
- Cables must be located away from high current carrying power cables such as engine or generator starter cables.
- Where the cables must pass through an area exposed to moisture, oil or dirt, use a fully sealed duct.
- Cable routes used for length measurement should be recorded to ensure the same route is used during installation.
- Allow spare cable length so that modules can be removed for servicing while still connected.
- Minimum bend radii for MECS cables should be 100mm

Take note of any special requirements by the Classification Authorities regarding the routing of cables.

For example, cables for Port and Starboard Jet Controls may need to be run on different sides of the vessel.

The Hydraulic System

The Jet Unit "Installation and Service Manual" contains additional information on fitting, removal and overhaul of the Reverse and Steering Components

- Make sure that all hydraulic hoses are connected correctly and secured following freighting and installation Refer: Drawing "CTHSE12076 Hose Kit" on Page 11-6.
- Check the JHPU Belt for correct tension. Refer: "Checking V-Belt Tension" on Page 8-5
- Check that linkages and wiring to position sensors are connected correctly and securely.

Spare V-Belts

Spare V-Belts can cause a potential hazard if not properly secured.

Make sure that spare V-Belts are fastened securely to the Jet Unit and do not come loose during vessel operation.

The Coupling will have a set of spare V-Belts and a label attached.
Make sure that the Mainshaft passes through the V-Belts. This will allow the spare V-Belts to be fitted without disconnecting the Driveshaft from the Coupling.

Filling the JHPU

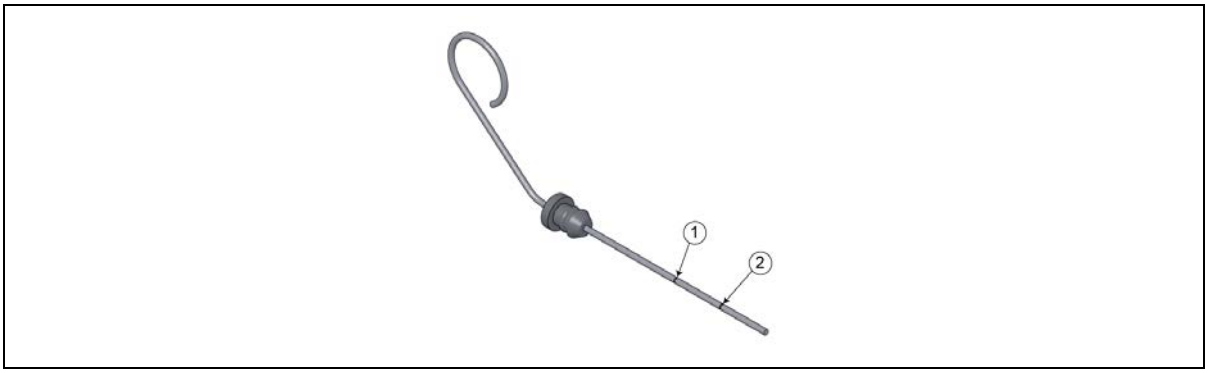


Figure 31: JHPU Dipstick

1 Maximum Oil Level
2 Minimum Oil Level

The JHPU is filled with oil via the filler cap on the JHPU tank. Fill until the oil reaches the "Max" mark on the Dipstick. Replace and tighten the Filler Cap firmly by hand.

Run the JHPU after vessel launch to purge any air from the system.

Check the oil level and top up as required. Refit the Filler / Breather.

Make sure that the oil used for filling the JHPU meets the specifications Refer: "Recommendations for Lubricants and Oils" on Page 10-18.

Mounting the Control Modules

Refer: Drawing "MECS Module Dimensions" on Page 10-33

Jet Control modules, Engine Control Modules, and Power & Interlock Modules should be securely mounted upright on a bulkhead close to their respective Jet Units.

Dynamic Positioning Interface Modules should be mounted close to the Dynamic Positioning System to minimise the length of cables carrying the analogue signals.

Avoid mounting the modules in areas of high vibration. If unavoidable, then rubber anti-vibration mounts must be used.

Control panel modules should be inclined at an angle to increase readability and to reduce the glare from sunlight.

Make sure there is enough clearance below modules to connect cables

The fronts of the modules should be readily accessible for Set-Up and access to the ***Backup*** or ***local*** controls.

Connect all MECS Modules to the Earth Bonding System.

It is important that there is a low impedance earth bond from the module to the ships hull or earth bonding system for RFI and EMI compliance. A Value of 1Ω or less is ideal.

Each module is fitted with an earth strap which must be bonded to the vessel structure (if metal) or earth bonding system using a spring or star washer to ensure a reliable connection

On steel hulled vessels the Jet Junction Box (JJB)must also be connected to the hull and ***NOT*** to the Jet Unit. The Jet Unit must remain isolated from the steel hull to minimise galvanic corrosion

Remote Jet Junction Box Mounting

The Jet Junction Box normally comes pre-mounted on the Jet Unit.

In some circumstances it may be necessary to mount the Junction Box away from the jet unit. Extra length conduits can be fitted to allow remote mounting.

The recommended mounting location of the Jet Junction Box is on the transom bulkhead directly aft of the jet unit, although the exact position will be determined by the lengths of the conduit.

The Anti-vibration bracket can either be welded or screw fixed to the bulkhead. Sufficient clearance must be provided above and below the bracket to allow access to the screws and cables of the Jet Junction Box.

Power Supply

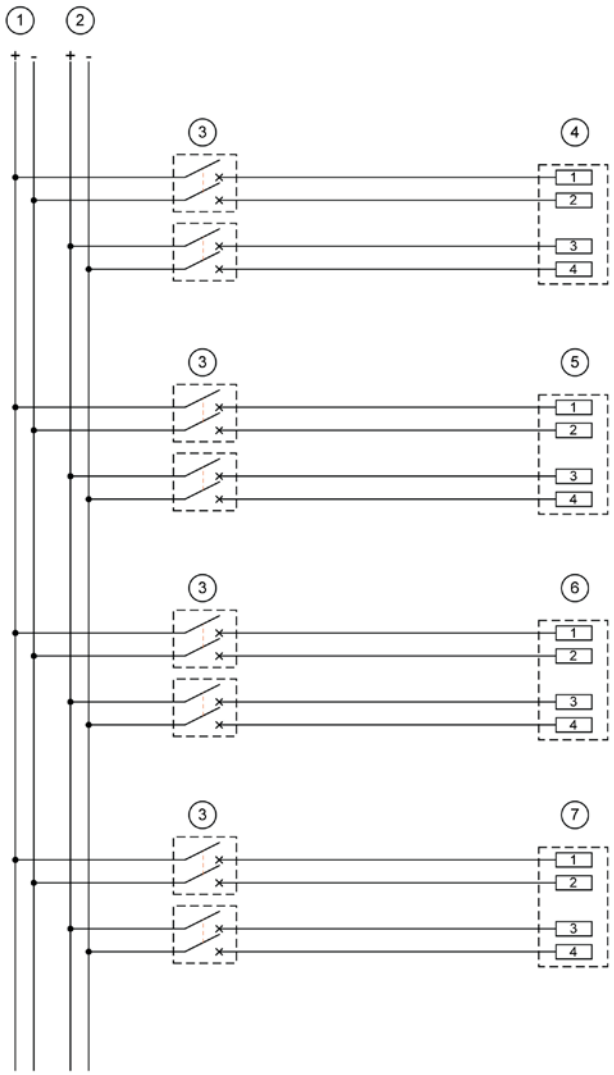


Figure 32: Recommended Power Supply Arrangement

	Description		Description
1	Primary Power Supply	5	Jet 2 Power and Interlock Module
2	Secondary Power Supply	6	Jet 3 Power and Interlock Module
3	20Amp Double Pole Circuit Breakers	7	Jet 4 Power and Interlock Module
4	Jet 1 Power and Interlock Module		

Circuit breakers and power wiring are not part of Hamilton Jet scope of supply

Control system current Requirements at 24v.

No of Jets	Primary Supply	Secondary Supply
	Continuous	Continuous
1	5A	5A
2	10A	10A
3	15A	15A
4	20A	20A

Refer: Figure "Power Supply" on Page 5-7

MECS must be connected to two independent and isolated 24V power supplies or batteries, each capable of supplying at least 5A per jet (i.e. 15A for a Triple jet) in accordance with voltage deviations as shown below.

Voltage tolerance:	-15% to + 30% of nominal DC system voltage
Voltage Cyclic Variation:	Maximum 15%
Voltage Ripple:	Maximum 10%

Environmental conditions (EMI/RFI) must be in compliance with limits defined in the technical specification

Refer: "MECS Technical Data" on Page 10-41

- A low battery warning operates at 20V.
- A minimum wire gauge of 2.5mm² is recommended.
- ***Do not use*** the engine starting batteries for supplying power to MECS.
- It is recommended that a fully filtered power supply device is used that includes over-voltage and reverse polarity protection with low output ripple and high regulation.
- Switching of the control system power from the engine ignition circuit is not recommended for engines with mechanical governors unless solenoid operated fuel shut off is fitted to stop the engine should electrical power be lost.

Connections between Modules

Connections between MECS Modules are made using Pre-Assembled cables.

The cable lengths must be determined and documented on the cable schedule attached to the project schematic. This schedule must then be returned to C.W.F.Hamilton Ltd so the cables can be manufactured.

To install the cables:

- Install the cable between modules using the Identification Labels at each end of the cable to determine the correct modules to connect with.
- Connect the cables to the Modules in the correct sequence as part of the Commissioning process.

Refer: Section 6 Commissioning.

Cable Identification Label

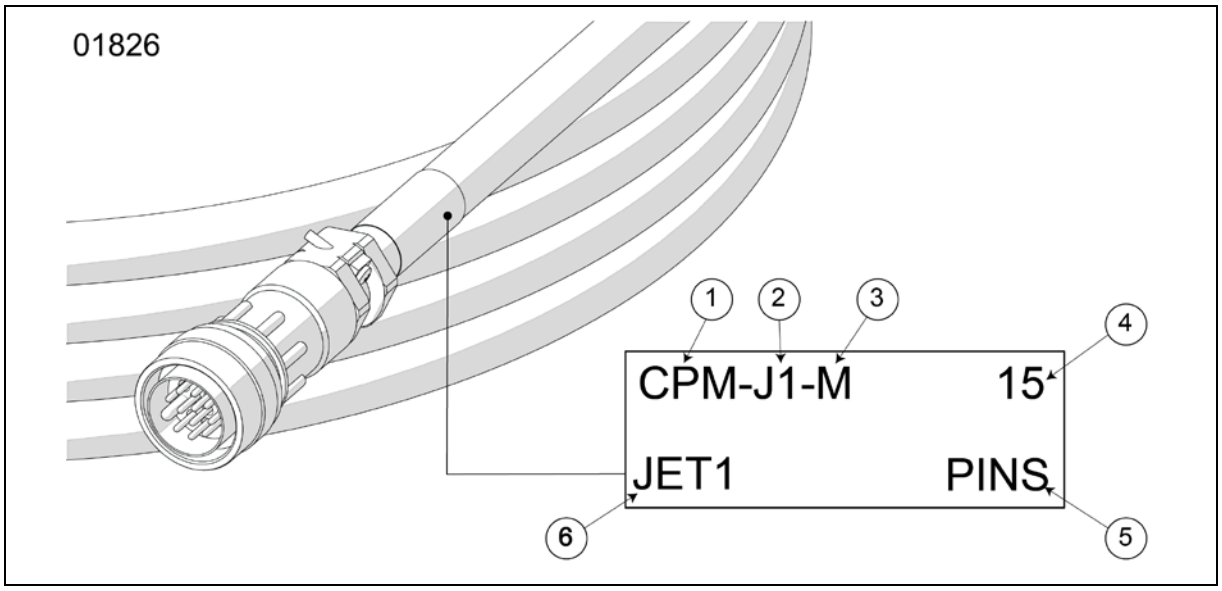


Figure 33: Cable Identification Label

1	Module that cable connects to	4	Cable Length in Meters
2	Module Connector that cable connects to	5	Cable Connector Type (Sockets or Pins)
3	Cable Polarising Pin Location	6	Jet Number / Control Station Number

Jet numbering is from Port to Starboard

Twin Jet	Jet1 = Port	Jet2 = Starboard		
Triple Jet	Jet1 = Port	Jet2 = Centre	Jet3 = Starboard	
Quad Jet	Jet1 = Port Outer	Jet2 = Port Inner	Jet3 = Starboard Inner	Jet4 = Starboard Outer

CS1	Control Station 1
CS2	Control Station 2
CS3	Control Station 3

Cables have a label attached to either end to help identify the correct module and socket the cable connects to.

Installing Cables

Most cables have a socket connector at one end and a plug connector at the other.

The Control System Schematic shows how the cables are installed.

When installing cabling:

- Install cables in the trays or ducts
- Do not install heavy cables on top of lighter cables.
- Space cable ties in accordance with relevant class rules or at a spacing of 250mm max.
- Keep cables parallel and avoid unnecessary crossovers.
- Avoid sharp edged cable ties or unprotected metal ties on lighter cable sheaths.
- Cross high current or potential noisy cables at right angles.

Independent Steering and Reverse Indicators

As an option, the Jet Units can be fitted with Steering and or Reverse indication independent of the MECS control system.

Each Jet Unit will have separate Steering and or Reverse sensors fitted which require wiring to Indicators mounted at the control station.

Cabling between the Sensors and Indicators are not part of C.W.F.Hamilton supply and should be provided by the shipyard.

Wiring diagrams and panel cutout dimensions can be found in the Technical drawing section of this manual.

Extra information is also supplied with the Indicators.

6 - Commissioning

In This Section

Before Launch

All Cylinder Shafts are protected with spiral wrap during shipping.

Make sure the wrap is removed before first operation.

Commissioning the Electronic Control System

Before connecting or disconnecting any components to the MECS system, ensure the Primary and Secondary power supplies are turned off.

All Cylinder Shafts are protected with spiral wrap during shipping.

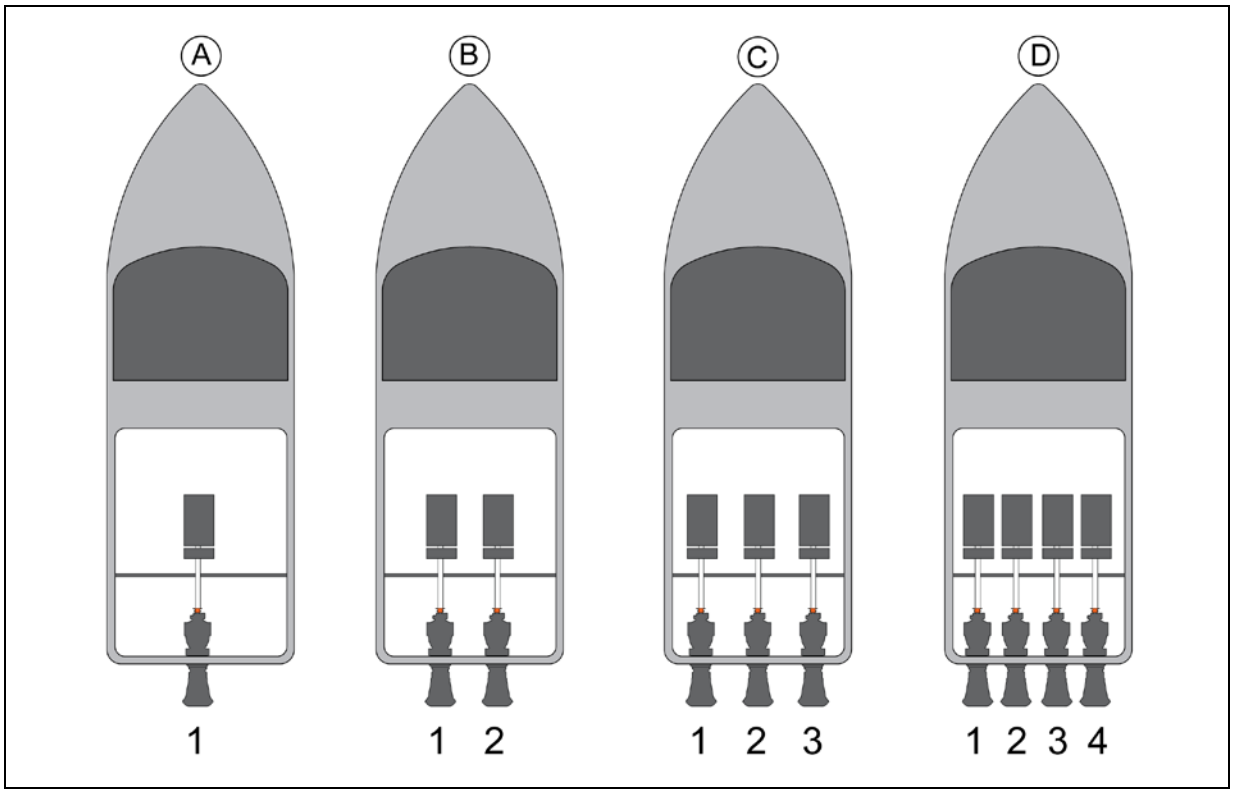
Make sure the wrap is removed before first operation.

Do not run the Jet Unit out of the water unless it is fitted with a Dry Run Kit. Commissioning involves the following:

- Checking power connections to the PIM.
- Connecting cables between Modules
- Power On Checks.
- Jet Control Module Setup.
- System tests at the dock and at sea.

6

Jet Unit Identification



Single Jet Twin Jet Triple Jet Quad Jet

Jet numbering is from port to starboard and must be in accordance with the ship specific schematic.

This numbering may be different to the engine manufacturer or monitoring system providers numbering system

Stage1 - Connecting 24VDC to the Power and Interlock Modules

These checks will confirm correct power wiring to the PIM, and the JCM powers up correctly.

Check the following:

- The earth on each MECS Module is connected to the ship's earth bonding system.
- Connector plugs at the JCM are not yet connected.
- Primary and Secondary supplies are switched *OFF* at the circuit breakers.
- The power supplies have been connected to the PIM's. Refer: Refer: "Connect to the Power and Interlock Module (PIM)" on Page 6-5
- Correct power supply polarity at the PIM's.
- Connect the (*Ui)* cable between the PIM and the JCM.
- Switch the JCM Selector switch to *NORMAL* mode.
- Switch *ON* the power to the JCM.
- The Display on the JCM should look similar to that shown below.

```
      ---- Jet Data ----
Mode  Normal-drive
Strg=28%  Rev=24%
Alarm:  *MissngModule
```

- Switch *OFF* the power to the JCM.

If the JCM does not power up correctly:

- Check Power supply voltage and connections to the PIM. If problems persists Contact C.W.F. Hamilton & Co Ltd or one of their authorised distributors.
- Repeat the above steps for all other JCMs and PIMs.

Stage 2 - Connect Module Cables

Make all connections between the Modules and check for correct operation of the system.

A terminating link *MUST* be fitted to both the R1 & Nx connectors of the last Control Panel Module in the chain.

Failure to do so will force the control system into Backup mode.

Do the following:-

- Switch *OFF* the power to all Power and Interlock Modules.
- Connect the cables between all control modules.
- Connect the Engine Control Module to the gearbox and engine.
- Refer to the Project specific Schematic and wiring diagrams supplied by C.W.F.Hamilton
- Switch all *NORMAL / BACK-UP* Switches at Control Panel Modules and Jet Control Modules to *NORMAL*.
- Terminal descriptions for user connected modules are listed below.

ECM Terminal Descriptions

Terminal #	I/O	Description
1	Input	'Drive' feedback
2	Input	'Neutral' feedback
3	Input	'Backflush' feedback
4	Input	Engine 'Local control' feedback
5	Input	Gearbox +24V
6	Input	Gearbox 'Interlock' feedback
7	Relay contact	Backflush solenoid drive (COM)
8	Relay contact	Backflush solenoid drive (N/O)
9	Relay contact	Neutral solenoid drive (N/C)
10	Relay contact	Neutral solenoid drive (N/O)
11	Relay contact	Neutral solenoid drive (COM)
12	Relay contact	Drive solenoid drive (N/C)
13	Relay contact	Drive solenoid drive (N/O)
14	Relay contact	Drive solenoid drive (COM)
15	Relay contact	Normal/Backup relay no 1 (COM)
16	Relay contact	Normal/Backup relay no 2 (COM)
17	Relay contact	Normal/Backup relay no 1 (N/O)
18	Relay contact	Normal/Backup relay no 1 (N/C)
19	Relay contact	Normal/Backup relay no 2 (N/O)
20	Relay contact	Normal/Backup relay no 2 (N/C)
21	Relay contact	Backflush solenoid drive (N/C)
22	Relay contact	'Engine start' relay (N/O)
23	Input	Auxillary Input (Rollover)
24	Relay contact	'Gearbox interlock' relay (N/C)
25	Relay contact	'Gearbox interlock' relay (COM)
26	Relay contact	'Gearbox interlock' relay (N/O)
27	Input	'RPM' feedback (COM)
28	Input	'RPM' feedback
29	Output	+24V aux output
30	Output	0V
31	Output	Open drain primary throttle signal
32	Output	Primary throttle signal.
33	Output	Primary throttle (COM)
34	Relay contact	'Engine start' relay (N/C)
35	Relay contact	'Engine start' relay (COM)
36	Output	Open drain secondary throttle signal
37	Output	Secondary throttle signal
38	Relay contact	Secondary throttle (COM).
39	Relay contact	Secondary throttle increment (N/O)
40	Relay contact	Secondary throttle increment (COM)

Terminal #	I/O	Description
41	Relay contact	Secondary throttle decrement (N/O)
42	Relay contact	Secondary throttle decrement (COM).

Connect to the Power and Interlock Module (PIM)

PIM Terminal Connection

Terminal #	I/O	Description
1	Input	Primary Power +
2	Input	Primary Power -
3	Input	Secondary Power +
4	Input	Secondary Power -
5	Inpu	Gearbox Switch +
6	Input	Gearbox Switch -
7	Relay Contact	Alarm Common
8	Relay Contact	Alarm Normally Open
9	Relay Contact	Alarm Normally Closed
10	Relay Contact	Engine Start Interlock Common
11	Relay Contact	Engine start Interlock normally Open
12	Relay Contact	Engine Start Interlock Normally Closed
13	Input	Engine Supply +
14	Input	Engine Supply -
15	Reserved Outputs	Switched Supply +
16	Reserved Outputs	Switched Supply -

Engine Start Interlock

- Prevents the engine from starting when the gearbox is *In-Gear* or when the SLC / Throttle lever is not in the Zero Speed / engine idle position.
- For this interlock to operate, The ECM start interlock relay must be connected to the engine start inhibit input, or in series with the start signal (depending on engine type)
- In vessels without E.C.M's the Engine start interlock is available via the PIM.
- If the engine start signal requires more than 1Amp inductive load, an external interposing relay should be fitted.

The engine start interlock *must* be used on vessels without a clutch.

This interlock function may be provided by the engine control system, in which case the MECS engine start interlock should not be used.

Refer: "ECM Terminal Descriptions" on Page 6-4

Connection to an External Alarm

External alarm connection to the Power and Interlock Module Terminals 7, 8 & 9:

The external alarm contact is a common alarm output from any alarm condition that exists on the Control Panel Module (CPM).

This contact will clear when the alarm is cancelled regardless if the alarm condition is still present.

Refer to the CPM to see which alarm is still current.

Any new alarms will re-close the external alarm contact.

Connection to an Autopilot

Autopilot Terminals

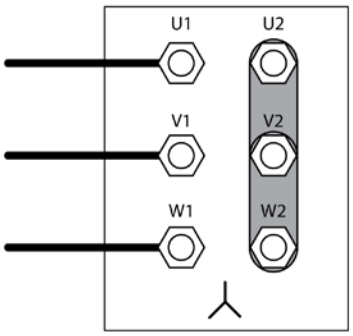
Terminal #	I/O	Description
1	Relay	Autopilot Enable Relay Normally Open, (Closes on enable)
2	Input	Autopilot V-
3	Input	Autopilot On
4	Input	Autopilot Alarm
5	Input	Autopilot Port Steering Demand
6	Input	Autopilot Starboard Steering Demand
7	Output	Autopilot Steering Feedback Signal
8	I/O	Autopilot Reference
9	Input	Autopilot Analog Steering Demand Signal
10	Relay	Autopilot Enable Relay Common
11	Relay	Autopilot Enable Relay Normally Closed, (Opens on enable)
12	I/O	RS485+ Communications Link
13	I/O	RS485- Communications Link
14	I/O	Communications Link Reference

Bearing Housing Oil Pump Starter

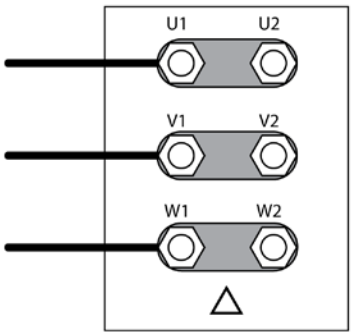
Connections for a 3 Phase motor

Terminal #	I/O	Description	Note
L1	Input	Three Phase Supply L1	Shipyard to confirm voltage and frequency
L2	Input	Three Phase Supply L2	
L3	Input	Three Phase Supply L3	
T1	Output	Pump Motor Supply U	Make sure the links in the motor terminal box are set for the correct voltage and frequency (see Below)
T2	Output	Pump Motor Supply V	
T3	Output	Pump Motor Supply W	
1	Input	Mains Earth	Refer to the Project specific Schematic and wiring diagrams supplied by C.W.F.Hamilton
2	Input	24v+	
3	Input	0v	

Motor terminal Links for 3Phase Motor:



380-420V 50Hz 0.18kW
440-480V 60Hz 0.216kW



220-240V 50Hz 0.18kW
250-280V 60Hz 0.216kW

Connections for a 1 Phase motor

Terminal #	I/O	Description	Note
L1	Input	Neutral	Shipyard to confirm voltage and frequency
L2	Input	Phase (Active)	
L3	Input	No Connection	
T1	Output	Internal Link	
T2	Output	Internal Link	
T3	Output	Pump Motor Supply	
1	Input	Mains Earth	Refer to the Project specific Schematic and wiring diagrams supplied by C.W.F.Hamilton
2	Input	24v+	
3	Input	0v	

Jet Unit Junction Box

All connections between the Jet sensors and solenoid valves, and the Jet Junction Box have been factory wired.
It should not be necessary to open the JJB except for servicing and the replacement of sensors etc.

Below is a list of Jet Junction box terminations.

AIN0		
1	Input	Reverse and Steering Sensor +ve
2	Input	Steering Sensor - Signal
3	Input	Reverse Sensor - Signal
4	Input	Reverse and Steering Sensor -ve

DIN0		
1	Input	Oil Level Sensor (JHPU) +ve
2	Input	Oil Pressure Switch (Bearing) +ve
3	Input	Oil Level Sensor (JHPU) - Signal
4	Input	Oil Temperature Switch (Bearing) - Signal
5		
6	Input	Oil Level Sensor (JHPU) -ve

AIN1		
1	Input	Oil Level Sensor (Bearing) +ve
2		
3	Input	Oil Level Sensor (Bearing) - Signal
4	Input	Oil Pressure Switch (Bearing) -ve
5		
6	Input	Oil Level Sensor (Bearing) -ve

AIN2		
1		
2	Input	Oil Temperature Sensor (JHPU) -ve
3	Input	Oil Temperature Sensor (JHPU) +ve
4	Input	Oil temperature Switch (Bearing) -ve

AIN3		
1		
2	Input	Oil Pressure Sensor (JHPU) -ve
3	Input	Oil Pressure Sensor (JHPU)+ve
4		

Terminal strip		
1	Output	Ahead Solenoid +ve
2	Output	Solenoid -ve
3	Output	Astern Solenoid +ve
4	Output	Solenoid -ve
5	Output	Port Solenoid +ve
6	Output	Solenoid -ve
7	Output	Starboard Solenoid+ve
8	Output	Solenoid -ve
9	Output	+ve (Not Used)
10	Output	-ve (Not Used)

Checking System Operation

- Switch *ON* the power to the control system.
- Cancel any alarms at the Control Panels.
- The JCM display for each Jet Unit should look similar to the following:

```
      --- Jet Data ---
Mode: Normal-drive
Strg=28%S  Rev=24%F
Alarm: No Alarms
```

- Confirm that switching the *Normal / Backup* selector switch at each JCM causes **Mode:** to change between **Normal** and **Backup**. Leave the switch in the *Normal* position.
- Confirm that switching the *Remote / Local1 / Local2* selector switch at each ECM causes the *Local1* and *Local2* Lamps to illuminate. Leave the switch in the *Remote* position.

At Each Control Panel Module Check:

- The *Primary* and *Secondary* power supply lamps are *ON* and steady.
- The Steering and Reverse Indicators are partially illuminated.
- Operation of the *Normal / Back-up* selector switch causes the *Normal / Back-up* Lamps to illuminate. Leave the Switch in the *Normal* position.
- Pressing *Alarm Cancel* causes the Panel Sounder to operate and all Lamps and transfer lamps to illuminate. (Lamp Test).
- Pressing *Dimmer* causes all lamps at the same Control Station to progressively dim.
- Make sure the selector switch is set to *Normal* at the JCM and all Control Panel Modules. Make sure that the *Backup* lamp at each panel is *OFF*.
- Make sure the left hand decimal point of the status indicator on each Panel is flashing slowly and the right hand decimal point is *ON* and Steady.
- On one of the Control Panels, set the selector switch to *Backup*. The right hand decimal point of the status indicator should flash slowly and the left hand decimal point should be *ON* and steady (On all Control Panels).
- Set all selector switches to *Normal.*

Make sure the electrical supply is isolated from the vessel hull by pressing the *LEAK1* switch in the PIM.

- If the Power Supply 0V is not isolated from the hull the LKN1 lamp will illuminate (the LKP1 LED will be *OFF*).
- If the Power Supply +24V is not isolated from the hull the LKP1 lamp will illuminate (the LKN1 LED will be *OFF*).
- If any problems are detected Refer: "MECS Faults" on Page 7-1.

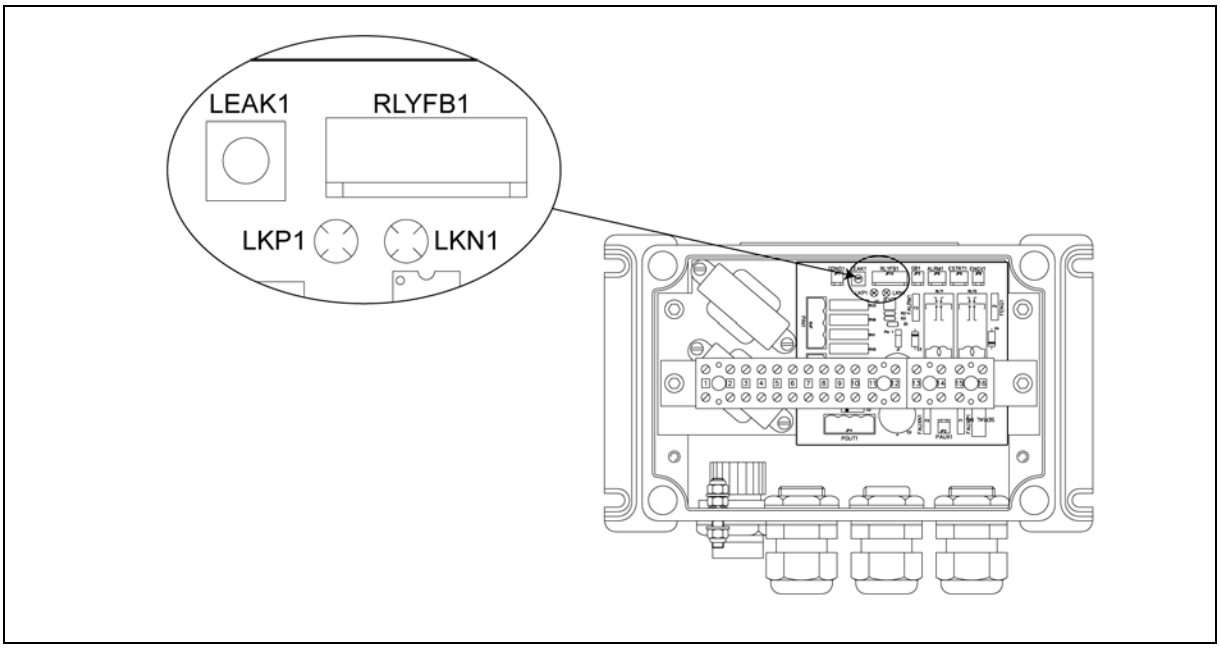


Figure 34: Earth Leakage Indication

6

Stage3 - Initial Set-up of MECS

A password is required to enter setup.

Contact C.W.F.Hamilton Ltd to obtain the default password.

It is recommended to change the password after setup is complete.

Control setup, except the Steering Nozzle and Reverse Duct, can be done before vessel launch. (The Steering and Reverse require hydraulics before they can be setup).

Setup is done at the Jet Control Module.

Step 1: System Setup

System Setup parameters:

- Total number of Jets.
- Individual Jet Identification Number.
- Full or Boost Control operation.
- Clearing Alarm Log.
- Changing Password.

Start System Setup

Switch *ON* the Control System.

The JCM will display the **Jet Data** menu or, if this is the first setup, the **Limbo** menu .

```
      ---- Jet Data ----
Mode  Normal-drive
Strg=28%  Rev=24%
Alarm:  *MissngModule
```

```
        ---- Limbo ----
          System Setup
            Jet Setup
          System Data
```

The system will detect alarms due to incomplete setup.

Press *CANCEL* at a Control Panel.

If at the **Jet Data** menu, press *ESCAPE*, to go to the **Main Menu**. (Not necessary if at the **Limbo** menu).

```
     ==== Main Menu ====
          System Data
            Jet Setup
       > System Setup <
```

Use the arrow keys to select **System Setup**

Press and Hold the *ENTER* button for 1 second to enter **SETUP (System).**

The **System Setup** option in the **Main** or **Limbo** menu is only available for 2 minutes after the JCM has been turned on.

After 2 minutes the **Main Menu** reverts to the **Jet Data** menu.

Password

When the JCM enters **SetUp (System)**, other Jet Units on the vessel will give **Missing Module** alarms because they are unable to communicate with a Jet Unit that is in Setup.

```
Mode: SETUP (System)
Password:0***
Adjust Value (↑&↓)
Ent=Next,   Esc=Quit
```

Select each digit using the arrow keys, then press *ENTER* to move to the next digit.

Press *ESCAPE* at any time to return to the **Jet Data** menu.

Entering the wrong password will return the menu to the **Jet Data** menu.

When the correct password is entered the display moves to the **Setup (System)** No. of Jets menu.

If no password is entered within 2 minutes the **SetUp (System)** page will revert to the **Jet Data** menu.

6

Number of Jets

Select the number of Jets in the vessel using the Arrow keys then press *ENTER*.

The number in brackets is the number of Jets currently set.

The number after the colon is the number of jets that will be set once the *ENTER* key is pressed.

```
Mode: SETUP (System)
No. Of Jets (1) : 1
Adjust Value (↑&↓)
□=Next,   X=Quit
```

Pressing *ESCAPE* moves the display to the **Setup (System)** Jet Identification menu.

Jet Identification

Set the identification number of the Jet by using the arrow keys then press *ENTER*.

The number in brackets is the currently set Jet identification.

The number after the colon is the Jet identification to be set once the *ENTER* key is pressed.

The jets are always numbered from port (I.D.1) to starboard.(I.D.X)

```
Mode: SETUP (System)
Jet Id.No (1) : 1
Adjust Value (↑&↓)
□=Next,   X=Quit
```

Pressing *ESCAPE* moves the display to the **Setup (System) - Control** menu.

Control Mode

Control for centre Jets on 3 and 5 Jet systems may be limited to 'boost' control only.

Boost Jets have no Reverse or Steering control (No Reverse Duct or Steering Nozzle fitted).

Select the control method of the Jet by pressing the Arrow keys then press *ENTER*.

The option in brackets is the currently selected control method.

The option after the colon is the control method to be set once the *ENTER* key is pressed.

```
Mode: SETUP (System)
Control (Full) : Full
Adjust Value (↑&↓)
□=Next,   X=Quit
```

Pressing *ESCAPE* moves the display to the **Setup (System) - Clear Alarms** menu

Clear Alarm Log

To clear the Alarm Log, press *ENTER*.

```
Mode: SETUP (System)
Clear Alarm Logs?

ENT = clr,   ESC=Skip
```

Pressing *ESCAPE* moves the display to the **Setup (System) - Change Password** menu

Change Password

```
Mode: SETUP (System)
Change Password?

ENT=yes,   ESC=no
```

To change the password press *ENTER,* the display changes to the **Setup (System) - Password Adjust Value** menu.

```
Mode: SETUP (System)
Password:0***
Adjust Value (↑&↓)
Ent=Next,   Esc=Quit
```

Select each digit using the Arrow keys then press *ENTER* to move on to the next digit.

Press *ESCAPE* at any time to return to the **Setup (System)- Change Password** menu.

After entering the new password, press *ENTER.* The display will change to the **Setup (System) - Save Password** menu.

```
Mode: SETUP (System)
Save Password?
Adjust Value (↑&↓)
Ent=Save,   Esc=Discard
```

To save the new password press *ENTER*.

To discard the new password and keep the old one, press *ESCAPE.*

The display returns to the **Setup (System)-Change Password** menu.

```
Mode: SETUP (System)
Change Password?

ENT=yes,   ESC=no
```

If you do not wish to change the password, press *ESCAPE* and the display will change to the **Reset** menu.

```
Mode: RESET
Exit Setup
```

After a few seconds the display will return to the **Jet Data**, or **Limbo** menu.

System Setup on this Jet unit has now been completed.

It is recommended to complete System Setup on all Jets Units. before commencing Jet Setup.

Step 2: Jet Setup

Jet Setup:

- Configures each MECS module.
- Each Jet set of modules is configured independent of other Jet sets.
- All parameters are cross checked by the system for compatibility.

For a complete list of Module parameters refer: Refer: "Module Parameter Summary" on Page 10-22

Start Jet setup

Power *ON* the Control System.

The JCM will display the **Jet Data** menu or, if this is the first setup, the **Limbo** menu .

```
      ---- Jet Data ----
Mode  Normal-drive
Strg=28%  Rev=24%
Alarm:  *MissngModule
```

```
      ---- Limbo ----
        System Setup
         Jet Setup
        System Data
```

The system will detect alarms due to incomplete setup.

Press *CANCEL* at a Control Panel.

If at the **Jet Data** menu, press *ESCAPE*, to go to the **Main Menu**. (Not necessary if at the **Limbo** menu).

```
==== Main Menu ====
      Alarm Log
     System Data
   > Jet Setup <
```

Use the arrow keys to select **Jet Setup**

Press and Hold the *ENTER* button for 1 second to enter **SETUP.**

The **Jet Setup** option in the **Main** or **Limbo** menu is only available for 2 minutes after the JCM has been turned on.

After 2 minutes the **Main Menu** page reverts to the **Jet Data** menu.

Password

When the JCM enters **SetUp**, all panels associated with that Jet Unit will display SU. Other Jets on the vessel will give **Missing Module** alarms because they are unable to communicate with a Jet Unit in Setup

```
Mode: SETUP
Password:0***
Adjust Value (↑&↓)
Ent=Next,   Esc=Quit
```

Select each digit using the arrow keys, then press *ENTER* to move to the next digit.

Press *ESCAPE* at any time to return to the **Jet Data** menu.

Entering the wrong password will return the menu to the **Jet Data menu**.

When the correct password is entered the display moves to the **Setup - Finding Modules menu**.

If no password is entered within 2 minutes the **SetUp** menu will revert to the **Jet Data** menu.

Finding Modules

The system will now try to find all attached modules, this will take a few seconds.

```
Mode: SETUP
Finding Modules
```

Once all modules are found the **Jet Setup - Select modules** menu appears.

Jet Setup

```
Mode: SETUP
Module: JCM #1/1
Select Module (↑&↓)
□=Enter,   X=Exit
```

Using the Arrow keys, scroll through the modules available for Setup .

- JCM = Jet Control Module
- ECM = Engine Control Module
- API = Autopilot Interface Module
- Panel = Control Panel Module

The first number is system assigned to the module.

The second number is the Identification Number of the Jet Unit the module connects to.

Panel Setup

- Using the Arrow keys, select the first Control Panel Module then press *ENTER*.
- The display changes to the **Setup - Panel - All** Menu.

```
Mode: SETUP
Module: Panel #1/1
All
□=Enter,   X=Exit
```

- To return to the **Jet Data** Menu, press *ESCAPE.*
- **All-** allows Panel parameters to be configured sequentially. Press *ENTER* to select **All**.
- After configuring the last parameter the display reverts back to the **Setup - Select Module** menu.
- To set individual parameters, use the Arrow Keys to scroll through the options. then press *ENTER* at the required parameter.
- Press *ENTER* to accept a new parameter value. Parameters can also be accepted by pressing *Cancel* at the Control Panel Module that is being configured.
- Press *ESCAPE* to leave the parameter value as is.
- Press *ESCAPE* to exit the **Setup - Panel** menu and return to the **Setup - Select Module** menu.

Engine Control Module Setup

- Using the Arrow keys, select the first ECM then press *ENTER*.
- The display changes to the **Setup - ECM - All** Menu.

```
Mode: SETUP
Module: ECM #1/1
All
□=Enter,   X=Exit
```

- To return to the **Jet Data** Menu, press *ESCAPE.*
- **All-** allows ECM parameters to be configured sequentially. Press *ENTER* to select **All**.
- After configuring the last parameter the display reverts back to the **Setup - Select Module** menu.
- To set individual parameters, use the Arrow Keys to scroll through the options. then press *ENTER* at the required parameter.
- Press *ENTER* to accept a new parameter value. Parameters can also be accepted by pressing *Cancel* at the CPM that is being configured.
- Press *ESCAPE* to leave the parameter value as is.
- Press *ESCAPE* to exit the **Setup - ECM** menu and return to the **Setup - Select Module** menu.

Engine Control Module Settings

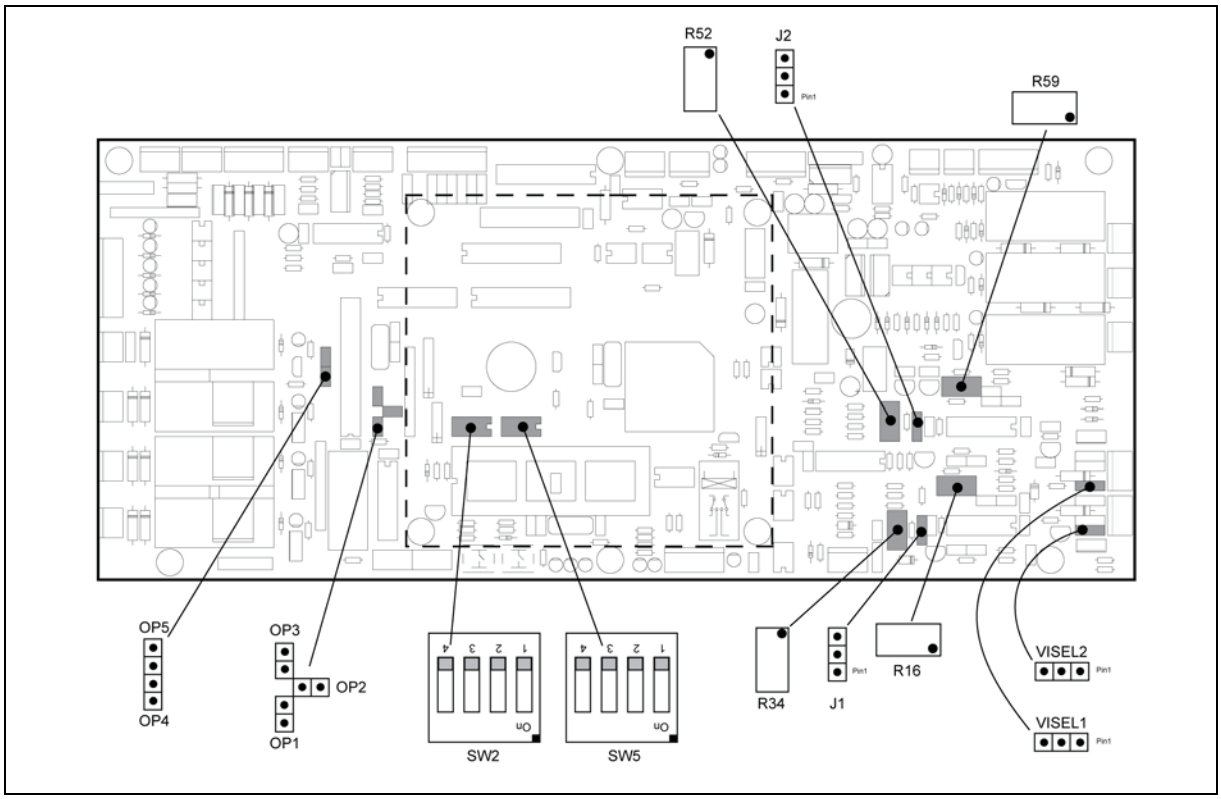


Figure 35: ECM Switch, Jumper and Potentiometer Locations

Engine Control Module switches, jumpers and potentiometers have been factory set for the correct engine and gearbox interface.

If an ECM is replaced, then these settings may need to be reconfigured.

ECM Engine Configurations

Switch, Jumper and Potentiometer settings for various engines and gearboxes are shown below.

MTU Electronic

Normal Throttle = 4-20 mA

Backup throttle = Inc/Dec Relays

Switch Settings

Jumper Settings

VISEL1 - 2 & 3 Linked

J1 - 2 & 3 Linked

Potentiometer Settings

R34 sets minimum 'Normal' Engine RPM.

R16 sets maximum 'Normal' Engine RPM.

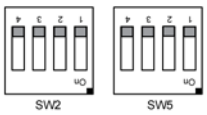
R52 and R59 have no effect.

Caterpillar

Normal Throttle = PWM (4% to 96% 500Hz

Backup throttle = PWM (4% to 96% 500Hz

Switch Settings



Jumper Settings

VISEL1 - 1 & 2 Linked, VISEL2 - 1 & 2 Linked

J1 - 1& 2 Linked, J2 - 1 & 2 Linked

Potentiometer Settings

R34 sets low voltage level of 'Normal" PWM signal.

R16 sets high voltage level of 'Normal' PWM signal.

R52 sets low voltage level of 'Back-Up' PWM signal.

R59 sets high voltage level of 'Back-Up' PWM signal.

DDEC

Normal Throttle = Frequency (100 to 500Hz)

Backup throttle = 0-5v

Switch Settings

Jumper Settings

VISEL1 - 1 & 2 Linked, VISEL2 - 2 & 3 Linked

J1 - 1 & 2 Linked, J2 - 1 & 2 Linked

Potentiometer Settings

R34 sets low voltage level of 'Normal' frequency signal.

R16 sets high voltage level of 'Normal' frequency signal.

R52 sets minimum 'Back-Up' engine RPM.

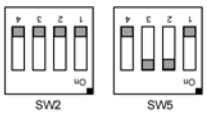
R59 sets maximum 'Back-Up' engine RPM.

Custom Frequency Output

Normal Throttle = Frequency

Backup throttle = Frequency

Switch Settings



Jumper Settings

VISEL1 - 1 & 2 Linked, VISEL2 - 1 & 2 Linked

J1 - 1 & 2 Linked, J2 - 1 & 2 Linked

Potentiometer Settings

R34 sets low voltage level of 'Normal" frequency signal.

R16 sets high voltage level of 'Normal' frequency signal.

R52 sets low voltage level of 'Back-Up' frequency signal.

R59 sets high voltage level of 'Back-Up' frequency signal.

Custom Frequency Output

Normal Throttle = PWM Signal

Backup throttle = PWM Signal

Switch Settings

Jumper Settings

VISEL1 - 1 & 2 Linked, VISEL2 - 1 & 2 Linked

J1 - 1 & 2 Linked, J2 - 1 & 2 Linked

Potentiometer Settings

R34 sets low voltage level of 'Normal' PWM Signal.

R16 sets high voltage level of 'Normal' PWM signal.

R52 sets low voltage level of 'Back-Up' PWM signal.

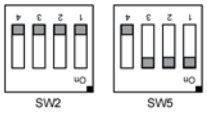
R59 sets high voltage PWM signal.

Custom 4-20mA Output

Normal Throttle = 4-20mA Signal

Backup throttle = 4-20mA Signal

Switch Settings



Jumper Settings

VISEL1 - 2 & 3 Linked, VISEL2 - 2 & 3 Linked

J1 - 2 & 3 Linked, J2 - 2 & 3 Linked

Potentiometer Settings

R34 sets minimum 'Normal' Engine RPM.

R16 sets maximum 'Normal' Engine RPM.

R52 sets minimum 'Back-Up' engine RPM.

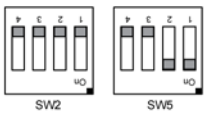
R59 sets maximum 'Back-Up' engine RPM.

Cummins Electronic (Voltage)

Normal Throttle = 0.8-4.5v

Backup throttle = 0.8-4.5v

Switch Settings



Jumper Settings

VISEL1 - 1 & 2 Linked, VISEL2 - 1 & 2 Linked

J1 - 2 & 3 Linked, J2 - 2 & 3 Linked

Potentiometer Settings

R34 sets minimum 'Normal' Engine RPM.

R16 sets maximum 'Normal' Engine RPM.

R52 sets minimum 'Back-Up' engine RPM.

R59 sets maximum 'Back-Up' engine RPM.

Cummins Electronic (Current)

Normal Throttle = 4-20mA Signal

Backup throttle = 4-20mA Signal

Switch Settings

Jumper Settings

VISEL1 - 2 & 3 Linked, VISEL2 - 2 & 3 Linked

J1 - 2 & 3 Linked, J2 - 2 & 3 Linked

Potentiometer Settings

R34 sets minimum 'Normal' Engine RPM.

R16 sets maximum 'Normal' Engine RPM.

R52 sets minimum 'Back-Up' engine RPM.

R59 sets maximum 'Back-Up' engine RPM.

ECM Configuration Links for Gearbox Types

Interface Type	Jumper Settings	Comments
Feedback		
Feedback	OP5 = Open	
No Feedback	OP5 = Linked	*No feedback* - Feedback derived from solenoid engage signals.
3 Feedback	OP2 = Open	
2 Feedback	OP2 = Linked	For a 3 position gearbox, the ECM expects in gear and in backflush feedback. For a 2 position gearbox, the ECM expects in gear and in neutral feedback.
Not Inverted	OP4 = Open	*Not inverted* - Normally open circuit, tied low on feedback.
Inverted	OP4 = Linked	*Inverted* - Normally low circuit,opens on feedback.
Drive		
Two Position	OP3 = Linked	
Three Position	OP3 = Open	

OP1 should be left open

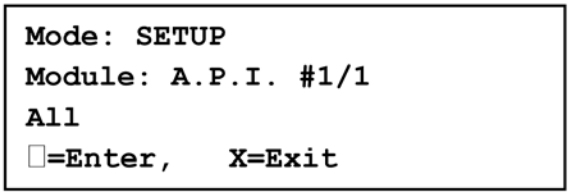
Fit jumper to GSEL Pins 1 and 2

6

Autopilot Interface Setup

Using the Arrow keys, select the first API then press *ENTER*.

The display changes to the **Setup - A.P.I. - All** Menu.



To return to the **Jet Data** Menu, press *ESCAPE.*

All- allows API parameters to be configured sequentially. Press *ENTER* to select **All**.

After configuring the last parameter the display reverts back to the **Setup - Select Module** menu.

To set individual parameters, use the Arrow Keys to scroll through the options. then press *ENTER* at the required parameter.

Press *ENTER* to accept a new parameter value.

Press *ESCAPE* to leave the parameter value as is.

Press *ESCAPE* to exit the **Setup - A.P.I.** menu and return to the **Setup - Select Module** menu.

6

Autopilot Interface Module Settings

The Autopilot Interface Module has been delivered with demand and feedback signal ranges correctly configured.

If the A.P.I. is replaced, internal links and settings. may need to be set up.

Consult your local C.W.F. Hamilton Jet Distributor for correct settings for your particular autopilot type.

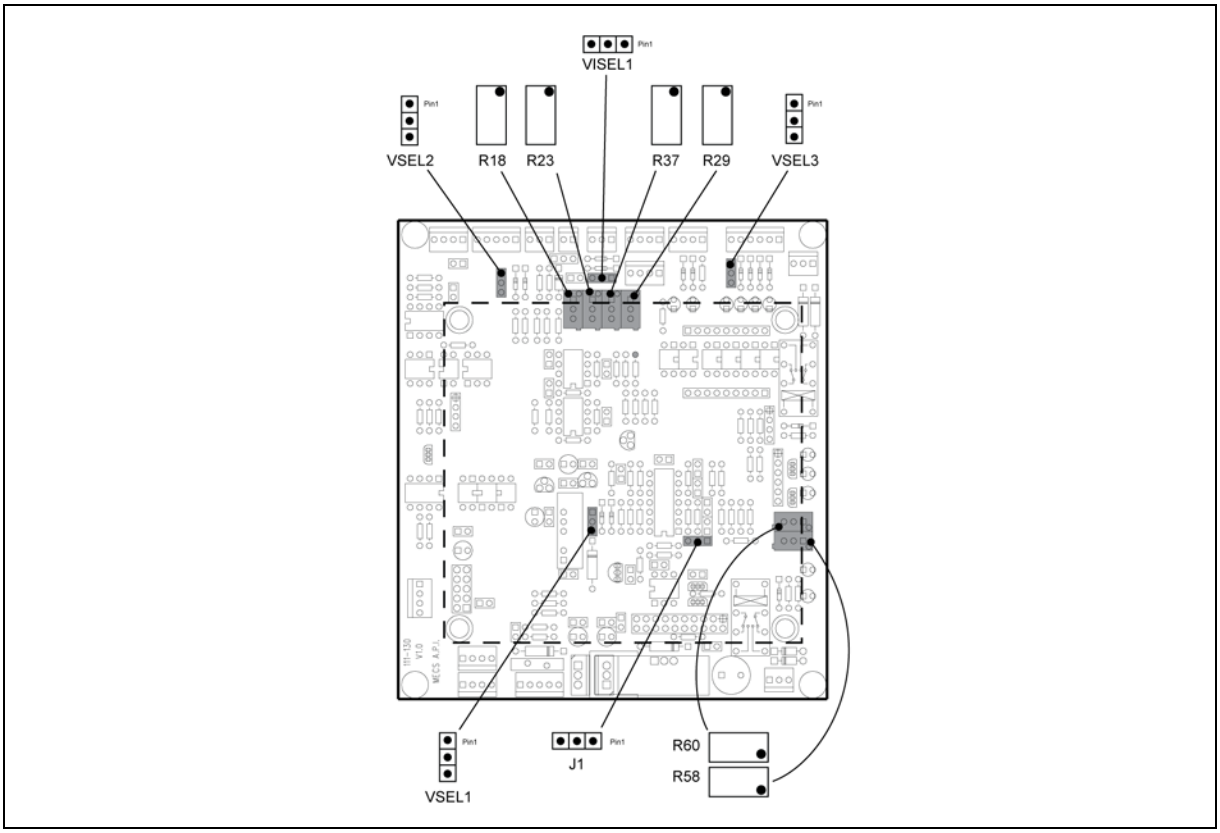


Figure 36: API Jumper and Potentiometer Locations

API Configuration

Steering Feedback Type	Jumper Settings	Potentiometer Adjustment
PWM	J1 - 1 & 2 Linked VISEL1 - 1 & 2 Linked	R58 gives minimum feedback signal. R60 gives maximum feedback signal.
Frequency	J1 - 1 & 2 Linked VISEL1 - 1 & 2 Linked	R58 gives minimum feedback signal. R60 gives maximum feedback signal.
Current	J1 - 2 & 3 Linked VISEL1 - 2 & 3 Linked	R58 gives minimum feedback signal. R60 gives maximum feedback signal.
Voltage	J1 - 2 & 3 Linked VISEL1 - 1 & 2 Linked	R58 gives minimum feedback signal. R60 gives maximum feedback signal.

VSEL1 = 1 & 2 linked for 0-5v feedback signal.

VSEL1 = 2 & 3 linked for -5 - +5v feedback signal.

VSEL3 = 2 & 3 linked.

VSEL2 = 1 & 2 Linked.

When setting up the mid helm demand parameter, adjust R18 (Offset) and R23 (gain) to scale the analogue steering demand signal from the autopilot so that at mid helm, the JCM display reads between 80 and 120.

Jet Control Module Setup

Refer: "Jet Control Module Setup" on Page 6-30

To setup the JCM, hydraulic power must be available at the Jet Unit.

This does not normally occur until after the vessel has been launched and the engines are operating.

Dynamic Positioning Interface Module Setup

When connecting the DPI for the first time, attach only the cable to MECS and leave the cables to the Dynamic Positioning System disconnected.

Make sure that the DPI modules have been 'found' by each JCM during Jet setup Refer: "Finding Modules" on Page 6-16.

Make sure that the azimuth and thrust signals from the Dynamic Positioning System are varying within the specified voltage ranges.(see Table Below)

Make sure that the *DP_ENABLED* contacts are closing by measuring resistance across pins 14 and 7 on the Ampseal plug.

Check the remaining connections for continuity between the Ampseal pins and the Dynamic Positioning System terminals.

Switch the Dynamic Positioning System power *off* and connect all cables between the Dynamic Positioning System and the DPI modules.

Switch the Dynamic Positioning System and MECS power *on.*

Setup MECS for number of jets and modules Refer: "Step 1: System Setup" on Page 6-10 then setup each DPI Module.

Make sure that the analogue signals between the Dynamic Positioning System and the DPI Module are correctly matched.

To do this:

- Set the Dynamic Positioning System signals to the nominal input and output ranges.
- With the Dynamic Positioning System in *Manual Thruster* mode. Match the DPI signals exactly to the Dynamic Positioning System signals during DPI setup.

Two people are required for this setup process with communication between the bridge and the engine room.

Full Port Azimuth	Zero Azimuth	Full starboard Azimuth	Zero Thrust	Full Thrust
-9v	0v	+9v	+1v	+9v

- Make sure that the Dynamic Positioning System supplies the signals shown in the above table to within +/- 0.1V
- Make sure that the Dynamic Positioning System is configured to accept feedback signals shown in the above table.
- With MECS in setup mode, use the Arrow Keys to select the DPI module.
- Select the **All** parameters then press *Enter*.

Set the parameters 1 and 2 Refer: ("DPI Setup Parameters" on Page 10-31)

Set the *PORT Azim-A* parameter.

- Set the Dynamic Positioning System azimuth signal to -180°, allow a 2 second settling time then press ***Enter***.

Set the *STBD Azim-A* parameter.

- Set the Dynamic Positioning System azimuth signal to +180°, allow a 2 second settling time then press ***Enter.***

Set the *MID Azim-A* parameter.

- Set the Dynamic Positioning System azimuth signal to 0°, allow a 2 second settling time then press ***Enter.***

Set the *MIN ThrustA* parameter.

- Set the Dynamic Positioning System thrust signal to 0%, allow a 2 second settling time then press ***Enter.***

Set the *MAX ThrustA* parameter.

- Set the Dynamic Positioning System thrust signal to 100%, allow a 2 second settling time then press ***Enter.***

Set the *PortA AzFbk* parameter.

- Adjust using the up/down arrow keys so that the feedback being read by the Dynamic Positioning System is exactly -180°

Set the *StdbA AzFbk* parameter.

- Adjust using the up/down arrow keys so that the feedback being read by the Dynamic Positioning System is exactly +180°

Set the *MidA AzFbk* parameter.

- Adjust using the up/down arrow keys so that the feedback being read by the Dynamic Positioning System is exactly 0°

Set the *Min ThrAFbk* parameter.

- Adjust using the up/down arrow keys so that the feedback being read by the Dynamic Positioning System is exactly 0%

Set the *Max ThrAFbk* parameter.

- Adjust using the up/down arrow keys so that the feedback being read by the Dynamic Positioning System is exactly 100%

If the DPI is being used with both channel A and B interfaces, repeat the above parameter setups for the channel B signals.

Set the remaining parameters to the desired values using the setup table as a guide. Most parameters will not require changing from their default values.

DPI Links Connectors and LED's

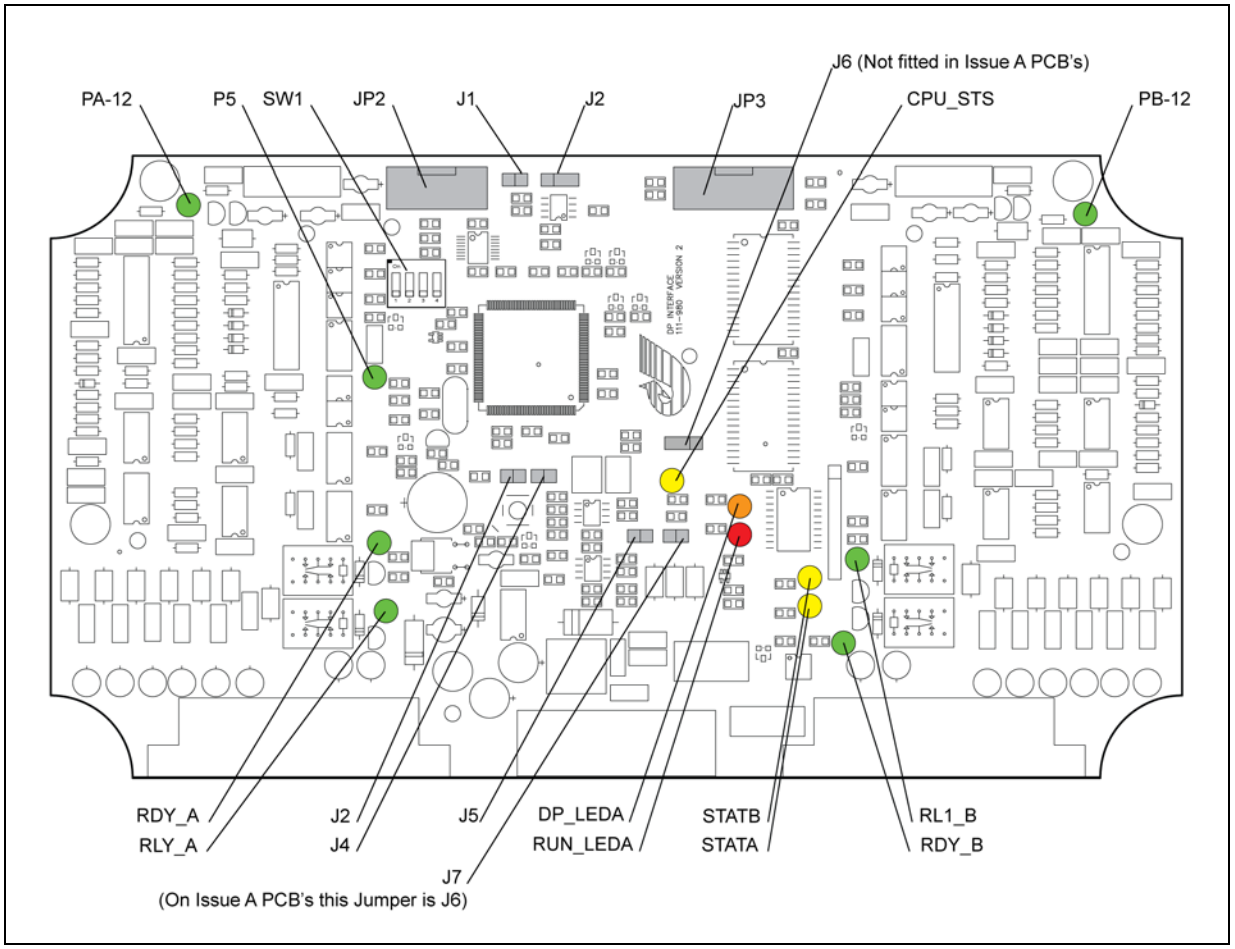


Figure 37: DPI PCB Connectors Links and LED's

Version 2 PCB Shown.
On Version 1(Issue A) PCB's, Jumper J6 is not fitted and Jumper J7 becomes J6

PCB Ref	Description	Function	Default	Notes
J1	Jumper – VCC programming voltage	OFF = Programming Disabled. ON = Programming Enabled.	Off	
J2	Jumper – Program/Run select	OFF = Run Mode. ON = Program Mode.	Off	
J3	Jumper - EEPROM Interface Type	Pins 1 & 2 Linked = SPI. Pins 2 & 3 Linked = I²C.	1 & 2 Linked	Solder linked to factory setting.
J4	Jumper - External Memory	OFF = External memory disabled. ON = External memory enabled.	On	Solder linked to factory setting.
J5	Jumper - CAN bur termination	OFF = no termination. ON = CAN+ and CAN- terminated.	Off	
J6	Version 1 PCB: Jumper - CAN bus Termination	OFF = no termination ON = CAN+ and GND terminated.	Off	
	Version 2 PCB: Jumper - emulation mode	Pins 1-2 linked = Normal Run Pins 2-3 linked = Emulate Mode	1 & 2 Linked	Solder linked to factory set\-ting.
J7	Version 1 PCB: Not fitted			
	Version 2 PCB: Jumper - Can bus termination	OFF = no termination ON = CAN+ and GND terminated.	Off	

PCB Ref	Description	Function	Default	Notes
JP2	Connector – Serial programming	N/A.	N/A	Used for in-system programming of flash OM.
JP3	Connector - JTAG	N/A.	N/A	Used for running the DPI with an emulator.
CPU_STAT	LED - +3.3V CPU supply	ON = +3.3V OK.	N/A	
P5	LED - +5V supply	ON = +5V OK..	N/A	
OP_LEDA	LED – CPU idle time	OFF = CPU busy. ON = CPU idle.	N/A	
RUN_LEDA	LED – Processor Run	Alternating ON/OFF = processor run.	N/A	
PA-12	LED – 'A' side isolated supply	ON = Isolated 'A' supply OK.	N/A	
STATA	LED		N/A	
RDY_A	LED – Jet Ready relay status 'A' side	ON = JET_READY (relay energised).	N/A	
RLY1_A	LED – Relay 1 status 'A' side	ON = Relay energised.	N/A	
PB-12	LED - 'B' side isolated supply	ON = Isolated 'B' supply OK.	N/A	
STATB	LED		N/A	
RLY1_B	LED – Relay 1 status 'B' side	ON = Relay energised.	N/A	
RDY_B	LED – Jet Ready relay status 'B' side	ON = JET_READY (relay energised).	N/A	
SW1	4 x Configuration DIP switches	Not currently used.	Off	Future option

6

DPI Programming Cable (Version 1 PCB's)

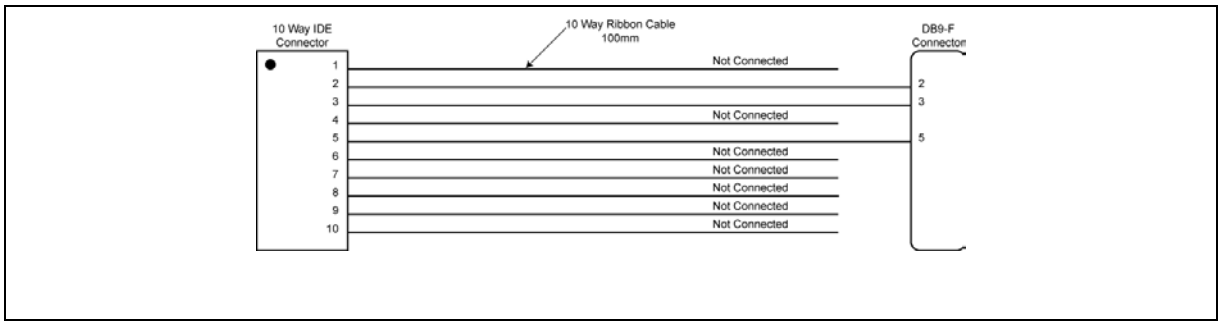


Figure 38: DPI Programming Cable (Version 1 PCB)

DPI Programming Cable (Version 2 PCB's)

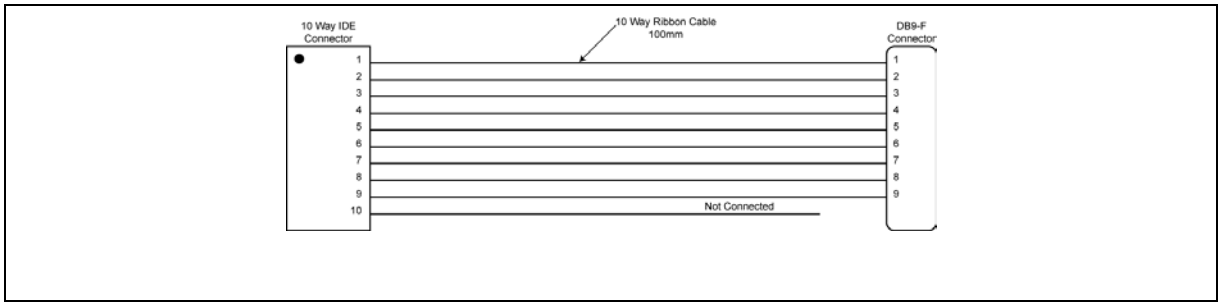


Figure 39: DPI Programming Cable (Version 2 PCB)

After Launch

Before Engine Start

Make sure that the vessel is securely moored during commissioning, as the Jet Unit can produce large thrust forces.

Do not continue if there are any control system fault alarms.

Do the following checks on each Jet Unit Control individually before moving to the next.

Make sure that no engines are operating.

Before starting the engine, check the following:

- The Control System power is *ON.*
- All gearboxes are in *Neutral*.
- The *Normal/Backup* selector switch on all Control Panels and Jet Interface Modules is in the *Normal* position.
- The *Local/Remote* selector switch on the Engine Control Module is set to the *Remote* position.
- The Master Station is *In Control* of the vessel, the control levers are in the *Zero Speed* position (centre detent) and the steering is set to *Ahead*.
- There are no alarms.
- A person is at the Bridge Station ready to move the Controls if required.
- Start the Engine.

After Engine Start

Make sure that there are no control system alarms then continue as follows:

After Engine Start

At the Control Panel Module:

- Set Idle RPM to *Minimum*.
- Push the *Drive*, *Neutral* and *Backflush* Pushbuttons.
  - Make sure that the driveshaft engages and disengages at the Jet Unit when the correct button is pushed.
  - Make sure that the correct gearbox position Indicator illuminates.
  - Make sure that the correct gearbox position is shown on Jet Control Module display.
- Set the *Normal/Backup* selector switch to *Back-Up.*
- Push the *Drive*, *Neutral* and *Backflush* Pushbuttons.
  - Make sure that the driveshaft engages and disengages at the Jet Unit when the correct button is pushed.
  - Make sure that the correct gearbox position Indicator illuminates.
  - Make sure that the correct gearbox position is shown on Jet Control Module display.
- Transfer control to each station and repeat the above checks.

At the Engine Control Module:

- Set the *Local/Remote* selector switch to *LOCAL1.*
- Repeat the gearbox checks given above, using the pushbuttons on the local Engine Control Module.
- Set the *Local/Remote* selector switch to *LOCAL2*
- Repeat the gearbox checks given above, using the pushbuttons on the local Engine Control Module.

Do any gearbox checks required by the gearbox supplier.

Check Engine Throttle Operation

Set the Control System to the *Normal* Mode:

Check that:

- The Gearbox is set to the *Neutral* position.
- The Engine Control Module and local engine controls are in the *REMOTE* Mode.
- The engine is running.

Use the Single Lever Control to change the engine speed.

- Check that the Engine Indicator shows the change in engine speed.

On the *In Control* Control Panel:*:*

- Use the RPM+ and RPM- Pushbuttons to make sure the engine idle speed may be adjusted from minimum to maximum RPM.

Set the Control System to *Back-Up* Mode:

- Use the RPM+ and RPM- Pushbuttons at any Control Panel to make sure the engine idle speed may be adjusted from minimum to maximum RPM.
- Set the *Local/Remote* Selector Switch on the Engine Control Module to *LOCAL1.*
  - Use the RPM+ and RPM- Pushbuttons on the local Engine Control Module to make sure the engine idle speed may be adjusted from minimum to maximum RPM.
- Set the *Local/Remote* Selector Switch on the Engine Control Module to *LOCAL2.*
  - Use the RPM+ and RPM- Pushbuttons to make sure the engine idle speed may be adjusted from minimum to maximum RPM.
  - Make sure the engine synchronisation function is operating correctly.
  - Make sure the engines are running at the same speed when in synchronisation.

Do any engine checks as required by the engine supplier.

Setting Backup Reverse and Steering Hydraulic Cylinder Speeds

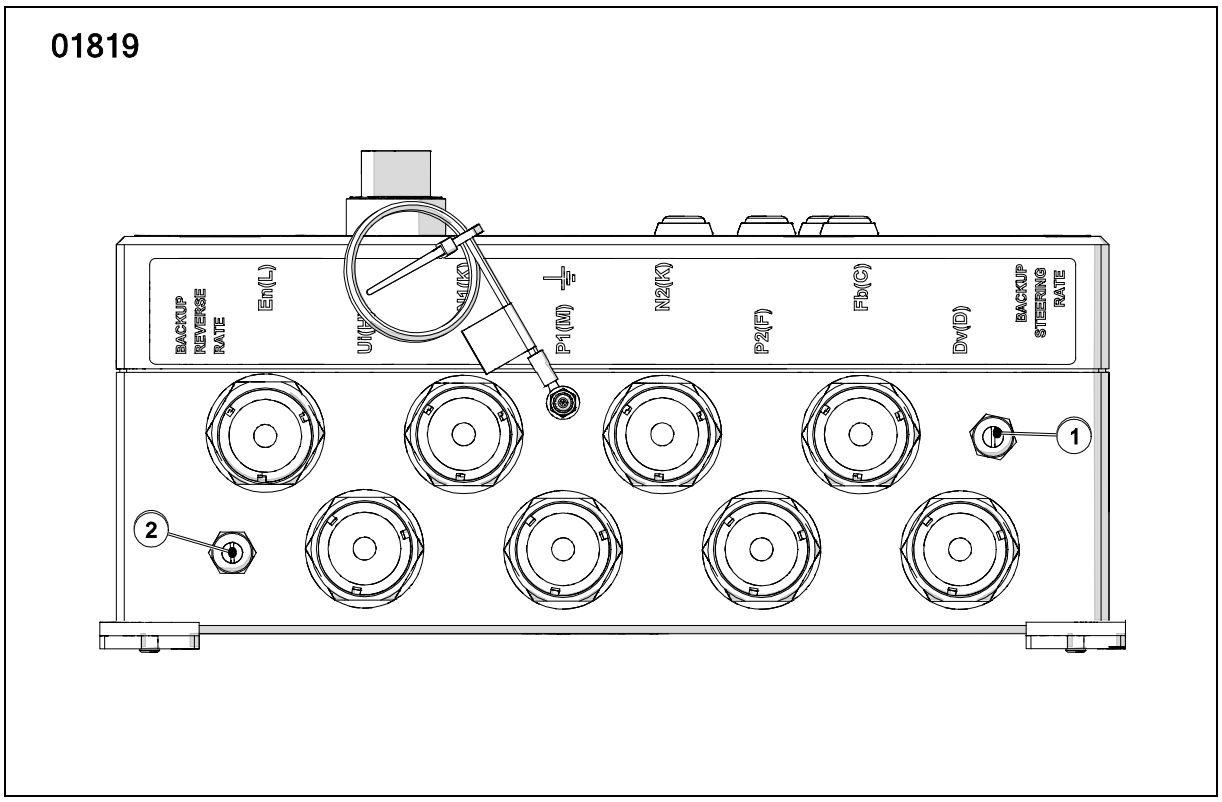


Figure 40: Backup Cylinder Speed Adjustment Controls

1 Backup - Steering cylinder travel speed Adjustment Potentiometer
2 Backup Reverse cylinder travel speed Adjustment Potentiometer

When the Control System is in ***Backup*** Mode, the travel speed of Reverse and Steering Hydraulic Cylinders can adjusted.

- Press the ***Backup*** pushbuttons on the Jet Control Module, this will cause each Hydraulic Cylinder to move.
- Check the speed of travel of the Hydraulic Cylinders.
- Adjust the Potentiometers on the bottom of the Jet Control Module to give a suitable travel speed (4-5 seconds end to end is recommended).
- The speed may be adjusted at sea to give optimum boat handling in ***Backup*** Mode.

Jet Control Module Setup

The Jet Control Module Set-Up can only be done after the vessel is launched and with the engines operating.

Make sure the vessel is securely moored and personnel are clear of the Jet Units.

Switch the Control System to *Normal.*

- Start the Engine and set the speed to low idle.
- Put the Gearbox in drive.
- At the Jet Control Module, enter the **`Jet Set-Up Select Module`** menu. Refer: Refer: "Finding Modules" on Page 6-16
- Using the arrow keys select the Jet Control Module then press *ENTER.*
- The display changes to the **`JCM Set-Up - All`** menu.

```
Mode: SETUP
Module: JCM #1/1
All
□=Enter,   X=Exit
```

- To return to the **`Jet data`** Menu, press *ESCAPE.*
- **`All`** - Allows JCM parameters to be set sequentially. Press *ENTER* to select **ALL**.
- After configuring the last parameter, the display reverts back to the **`Jet Set-Up Select Module`** menu.
- To set individual parameters, use the arrow keys to scroll through the options, then press *ENTER* at the required parameter.
- The JCM automatically sets all but two of it's parameters. Watch the display to see when user input is required.
- Press *ENTER* to accept a new parameter value.
- Press *ESCAPE* to leave the parameter as is.

A description of the user input parameters follows.

Dead Ahead Steering Position

```
Mode: SETUP
Module: JCM #1/1
StrgMid Fb (80) 80
Set Steering MID (←&→)
```

This parameter sets the feedback for the *Dead Ahead* Steering Nozzle position.

The Steering Nozzle can be adjusted using the up and down arrow keys.

The nozzle is at *Dead Ahead* when the steering crank indicator is at 0°.

The steering *Dead Ahead* position can also be adjusted by setting the Control System to *Backup* and using the backup steering control.

Zero Speed Reverse Duct Position

```
Mode: SETUP
Module: JCM #1/1
RevNeut Fb (6ab) 6ab
Set ZERO SPEED (↑&↓)
```

This parameter sets the feedback for the *Zero Speed* Reverse Duct position.

The Reverse Duct can be adjusted using the up and down arrow keys.

The *Zero Speed* position can only be accurately determined during vessel operation. The position is usually close to the 2/3 down position.

The *Zero Speed* position can also be adjusted by setting the Control System to *Backup* and using the Backup Reverse Duct control.

When the JCM Setup is finished, press *Escape* to go back to the Jet Data menu.

For further parameter details Refer: "Module Parameter Summary" on Page 10-22

6

Purging Air from the Hydraulic System

Do not move the Control Levers or Cylinders whilst purging air from the JHPU system

This may cause contamination to enter the JHPU.

- Operate the engine at idle speed.
- Put the gearbox in *Drive.*
- Set the control levers to *Zero Speed*.

Let the JHPU operate for 15 minutes, this will:

- Filter unwanted material from the oil.
- Expel air in the Oil Cooler and JHPU.
- Expel air suspended in the oil.

Make sure that the oil pressure is approximately at the *Stand-By* pressure of 220 psi (15 Bar). This can be read on the Jet Control Module display.

The *Stand-By* pressure has been factory set to 220 psi (15 bar) at idle and should not require adjusting.

- Top up the JHPU oil level during purging to prevent air entering the system.

After initial purging, the Reverse and Steering Cylinders must be purged by Moving the cylinders fully in and out about 5 times.

To purge the cylinders:

- Set the Control System into *Backup* mode.
- Move the *Backup* Jogstick to move the cylinders.
- Top up the JHPU.

Continue to operate the JHPU for at least 15 minutes to remove any air and dirt that may have re-entered the hydraulic system.

Look for leaks around the JHPU, Hydraulic Cylinders and Hose Connections.

Fix any leaks found.

Final System Tests

All system tests described in this Section must be done before the vessel is operated at sea.

Preparation

Make sure that control power is *ON* and that the vessel is securely moored.

Switch the selector switch at all Control Panels and JCMs to *Normal*.

Set all Reverse / Throttle Control Levers to *Zero Speed*.

If the Master Station is not *In Control,* press the *Take Control* button on the Helm Module at the Master Station.

The Control Lamp on the Helm Unit will flash and the centre Lamp on the Control Panels will illuminate to indicate that control has been taken.

Operate the engine at low idle and put the gearbox in *Drive*.

Steering Control Tests

- Turn the Master Station Helm fully to port.
- Make sure that the Steering Nozzle Position Indicators on All Control Panel Modules indicate correctly.
- Make sure that the Steering Nozzles on All Jets have moved fully to port and that the steering thrust is in the correct direction.

Repeat the above steps for the starboard helm direction.

Centre the Helm and make sure that:

- The Steering Nozzles return to the *Dead Ahead* (Centre) position.
- Make Sure that the Steering Position Indicators on all Port Control Panels indicate the *Zero Speed* position (The Lamps either side of the centre Lamp are illuminated).

Reverse Control Tests

At the Master Station:

- Move the Port Reverse/Throttle Lever to *Full Ahead*.
- Make sure that the Reverse Indicators on all Port Control Panels indicate correctly.

On aft facing Control Panels, the fully raised Reverse Duct position is shown by the illumination of the lower half of the Reverse Duct Position Indicator.

If the reverse indication is inverted then the control panel has been configured as a forward facing panel (or vice versa).

- Move the Port Master Reverse/Throttle Lever to the *Full Astern*.
- Make sure that the Reverse Indicators on all Port Control Panels indicate correctly.
- Move the Reverse/Throttle Lever to the *Zero Speed* position.
- Make Sure that the Reverse Indicators on all Port Control Panels indicate the *Zero Speed* position (The Lamp immediately above and below the centre Lamp are illuminated).

Repeat the above Steps for the Starboard Reverse/Throttle Lever.

Remote Control Station Tests

Transfer control to each of the Control Stations in turn.

- Repeat the Steering Control Tests as described above.
- Repeat the Reverse Control Tests as described above.

Backup Control Tests

For the first Jet Unit:

- At the Master station Control Panel, set the *Normal/Backup* Selector Switch to *Backup*.
- Using the Backup Jogstick:
  - Move the Steering Nozzle to the limits of its travel (full Port, full Starboard).
  - Make Sure that the Steering Position Indicators at the Master and Remote Station(s) illuminate correctly.
  - Make sure that the Steering Nozzle moves to the selected position.
  - Move the Reverse Duct to the limits of its travel (full Ahead, full Astern).
  - Make Sure that the Reverse Duct Position Indicators at the Master and Remote Station(s) illuminate correctly.
  - Make sure that the Reverse Duct moves to the selected position.
- Repeat the above checks at all Remote Control Stations.
- Centre the Steering Nozzle.
- Set the Reverse Duct to the *Zero Speed* position.
- Set the *Normal/Backup* Selector Switch to *Normal*.

Repeat the above tests for each of the other Jet Units.

Control Transfer Tests

Make sure that all *Normal/Backup* selector switches are set to *Normal*.

Make sure that Control Transfer is:

- *Possible* between Control Stations when all Reverse/Throttle Levers are set to the *Zero Speed* position.
- *Not possible* between Control Stations if any Reverse/Throttle Lever is not set to the *Zero Speed* position.

Repeat control transfer tests between all Control Stations.

Manoeuvring Joystick Module Test

(Only necessary if a Manoeuvring Joystick is fitted.)

Complete all tests described previously, then do the following:

- Make sure that all *Normal/Backup* selector switches are set to *Normal*.
- Make sure that the Manoeuvring Joystick Module is centred.
- Press the *Take Control* button on the Manoeuvring Joystick Module.
- Make sure that control transfer has occurred and that the *Take Control* indicator is now flashing.
- Make sure that the Position Indicators on all Control Panels are showing the *Zero Speed* and *Dead Ahead* positions.
- Make sure that the RPM on all engines is at idle.

Move the Manoeuvring Joystick Ahead.

- Make sure that the Steering Position Indicator on all Panels is showing the *Dead Ahead* position.
- Make sure that the RPM on all engines increases.
- Make sure that the Reverse Position Indicator on all Panels is showing and that the Reverse Ducts are partially raised.

Move the Manoeuvring Joystick Astern.

- Make sure that the Steering Position Indicator on all Panels is showing the ***Dead Ahead*** position.
- Make sure that the RPM on all engines increases.
- Make sure that the Reverse Position Indicator on all Panels is showing that the Reverse Ducts are partially lowered.

Move the Manoeuvring Joystick to Port.

- Make sure that the Reverse Position Indicator on all Port Panels is showing that the Reverse Ducts are partially lowered.
- Make sure that the Reverse Position Indicator on all Starboard Panels is showing that the Reverse Ducts are partially raised.
- Make sure that the RPM on all engines increases.

Move the Manoeuvring Joystick to Starboard.

- Make sure that the Reverse Position Indicator on all Starboard Panels is showing that the Reverse Ducts are partially lowered.
- Make sure that the Reverse Position Indicator on all Port Panels is showing that the Reverse Ducts are partially raised.
- Make sure that the RPM on all engines increases.

Turn the Manoeuvring Joystick 3rd axis fully to Port.

- Make sure that the Steering Position Indicators on all Panels show that the Jet Units have steered to Port.

Turn the Manoeuvring Joystick 3rd axis fully to Starboard.

- Make sure that the Steering Position Indicators on all Panels show that the Jet Units have steered to Starboard.

Centre the Manoeuvring Joystick 3rd axis.

- Move the Manoeuvring Joystick Ahead
- Move the primary Reverse/Throttle levers fully forward.
  - Make sure that the RPM on all engines increases when moving the Reverse/Throttle levers .
  - Return the Reverse/Throttle levers to the ***Zero Speed*** position
  - Return the Manoeuvring Joystick to the centre position.

During Trial Checks

Hydraulic System

Check the hydraulic oil temperature in the JHPU Tank:

- After 10 to 15 minutes of operation.
- If satisfactory, repeat after 1hour of operation at high engine RPM.

Maximum allowable temperature is 65°C.

The oil temperature will vary depending on:

- Engine speed.
- Engine room temperature.
- Water temperature.
- Hydraulic activity.

With the Pump running and the proportional valves de-energised, the stand-by pressure should be 218-psi (15 bar) at normal operating temperature.

On cold start-up, the stand-by pressure will be slightly higher.

Bearing Housing

Check the oil temperature (Refer to the Jet Unit Installation and Service Manual).

Check the Oil Level in the Bearing Housing.

Check for Oil leaks around the Bearing Housing.

Oil Leaks

Look for oil leaks around the Hydraulic Power Unit, Oil cooler and hose connections.

Steering Nozzle

- Make sure that all Steering Nozzles point in the same direction at all helm positions.

7 - Fault Finding

In This Section

MECS Faults

Make sure that Primary and Secondary Power supplies to the Control System are *OFF* before connecting or disconnecting any Modules.

There are two types of Fault:-

Operational Faults:

- The Control System does not respond as expected but no alarms are generated.

System Generated Faults:

- The Control System has detected a fault condition and has generated an alarm.

Operational Faults

This Section explains unexpected operations of the Control System.

Many of these faults may not cause Alarm warnings but are system interlocks, present to prevent damage or to avoid dangerous situations.

The Jet Unit does not respond to Normal Control.

Possible Cause	Solution
Engine not running	Start Engines
Gearbox not in *Drive*	Select *Drive*
Jet not in *Normal*.	Select *Normal* at all CPMs and JCM
No power to the JCM	Check external fuses and circuit breakers
Station is not in control	Transfer Control to the required station

The Jet Unit does not respond to Backup Control.

Possible Cause	Solution
Engine not running	Start Engines
Gearbox not in *Drive*	Select *Drive*
Jet not in *Backup*.	Select *Backup* at all CPMs and JCM
No power to the JCM	Check external fuses and circuit breakers
Backup speed adjustment on JCM set to low	Increase *Backup* cylinder speed

Gearbox does not Change Gear When Buttons Pushed

Possible Cause	Solution
Engine not running	Start Engines
Control Panel not *In Control*	Transfer Control to the required Panel
Engine RPM is too high to allow gear change.	Reduce throttle and or idle settings.
Reverse/Throttle Lever at CPM in control is not set to *Zero Speed*.	Set the Reverse/throttle Lever to *Zero Speed*.
Backup speed adjustment on JCM set to low	Increase *Backup* cylinder speed

No Gear Position Indication on the Control Panel

Possible Cause	Solution
Bulb blown	Use lamp test to check bulbs. Replace if blown
Dimming level set too low on the CPMs.	Raise dimming level by pressing *Dimmer* button.

7

No In Control Indication on the Control Panel

Possible Cause	Solution
Bulb blown	Use lamp test to check bulbs. Replace if blown
Dimming level set too low on the CPMs.	Raise dimming level by pressing *Dimmer* button.
Control Station is not in control	Transfer control to the required station

Idle RPM Adjust Not Operating

Possible Cause	Solution
Engine not running.	Start engine.
Control Panel is not in control	Transfer control to the required station.
Engine idle RPM is already at it's maximum or minimum.	

Normal Jet Controls Operate Slowly

Possible Cause	Solution
Partially open By-pass Valves on JHPU.	Firmly close By-Pass Valves.
V-Belts slipping.	Replace or tighten V-Belts as necessary.

Engine Will Not Start

Possible Cause	Solution
Gearbox is not in *Neutral.*	Move gearbox to neutral position manually.
Throttle set too high.	Reduce throttle setting by decreasing idle speed and throttle lever setting.

System Generated Faults

When a fault is detected by the Control System, an audible Alarm will be heard and a two digit Alarm Code will be shown on the Control Panel display.

More detailed alarm information will be shown on the Jet Control Module display.

MAKE SURE THAT THE VESSEL IS IN NO DANGER

Then Do the following:-

- Take note of the two digit alarm code shown on the Control Panel display.
- Press the *Cancel* Button to silence the alarm.
- If multiple Alarms occur, pressing the *Cancel* Button will cancel the highest priority alarm, lower priority alarms will then be displayed.
- look at the JCM Alarm Log to find out:
  - The alarm type.
  - The module which detected the alarm.
  - If the alarm is still active (a * will be displayed next to the alarm description).

Refer: "System Generated Faults" on Page 7-3: for a description of this alarm and possible solutions.

After recovering from a fault, the Control System should be switched off and then back on again.

To allow fail safe operation of the vessel, faults detected in the Steering (including Autopilot), Reverse or Throttle during *Normal* mode, will result in the throttle being set back to idle.

To continue in *Normal* mode:

- Remove the alarm, then bring the Reverse/Throttle Control back to the *Zero Speed* position.

7

Alarm Codes

Ao	
Alarm Log Text	MissingMod=?X
Alarm Description	A module is missing ? = Module ▪ J = JCM ▪ E = ECM ▪ P = CPM ▪ A = API X = Module Number
Active in Normal	Yes
Active in Backup	No
Possible Cause	Power loss to module ▪ Blown fuse in JCM. ▪ Cabling fault. Communications lost with module ▪ Cabling fault. ▪ API failure. Incomplete module Set-Up.
Solution	▪ Replace Internal fuse in the JCM. ▪ Make sure Interconnecting Cables have been installed correctly. ▪ Switch the Control System power off then back on. If the module remains missing ('*' displayed in the alarm log) then replace the Module.

AA	
Alarm Log Text	AutoPilot Aux
Alarm Description	The API auxiliary input signal has become active. (unused).
Active in Normal	Yes
Active in Backup	No
Possible Cause	Not used in the current version of software.
Solution	Not used in the current version of software.

Ac	
Alarm Log Text	Config Err=?c
Alarm Description	Incompatible configurations on two modules ▪ '?c' = the parameter in conflict ▪ 'E' = more than one API is connected.
Active in Normal	Yes
Active in Backup	No
Possible Cause	Two modules have incompatible settings - may be due to: ▪ Incorrect Initial Set-Up. ▪ Replacement module has not been Set-Up.
Solution	▪ Make sure that only 1 API is installed. ▪ Set-up the modules correctly.

Ad	
Alarm Log Text	Duplicate API
Alarm Description	The system detects two API's connected to the same jet
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Incorrect Module Set-Up, e.g. 2 Jets with the same Id ▪ Replacement API with incorrect Set-Up.
Solution	▪ Set-up each JCM. making sure that all modules been correctly detected.

AE	
Alarm Log Text	EE Corrupt ?
Alarm Description	There is a memory fault in the API, '?' gives the cause: ▪ C =Checksum incorrect. ▪ S = Status incorrect ▪ D = Contains defaults. ▪ a = First parameter is invalid. ▪ b = Second parameter is invalid. ▪ c = Third parameter is invalid, etc.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Power failure during Set-Up. ▪ Defaults restored and subsequent Set-Up not done.
Solution	▪ Set-Up the module causing the alarm. ▪ If problem continues, replace the module.

AF	
Alarm Log Text	SelFtest Fail
Alarm Description	The API startup self test has failed.
Active in Normal	Yes
Active in Backup	No
Possible Cause	The API has detected an internal fault and may be damaged.
Solution	▪ Switch the Control System power off then back on. ▪ Set-up the module. ▪ If the problem persists replace the module.

AP	
Alarm Log Text	AutoPilot=ON
Alarm Description	The autopilot is in controls of the helm.
Active in Normal	Yes
Active in Backup	No
Possible Cause	The Autopilot is operating in Auto Mode.
Solution	Switch the Autopilot to Manual to return control to Normal Mode.

AS	
Alarm Log Text	AP Dmd Signal
Alarm Description	The autopilot demand signal is out of range.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Fault in the Auto Pilot. ▪ Fault in the wiring between the Autopilot and the API. ▪ Fault in the API
Solution	▪ Check the wiring between the autopilot and the API. ▪ Make sure the autopilot demand signals are correct. ▪ Switch the Control System power off then back on. ▪ Replace the API.

At	
Alarm Log Text	AP Fault
Alarm Description	The Auto Pilot has generated a fault signal.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Fault in the Auto Pilot. ▪ Fault in the wiring between the Auto Pilot and the API. ▪ Fault in the API.
Solution	▪ Check the wiring between the autopilot and the API. ▪ Make sure that the Autopilot is operating correctly (Refer to Autopilot operation information). ▪ Make sure the autopilot fault signal is correct. ▪ Switch the Control System power off then back on. ▪ Replace the API

A-	
Alarm Log Text	AP Disabled, AP Off
Alarm Description	The Autopilot has been switched to Manual.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ The Autopilot has been switched off. ▪ No power to the autopilot.
Solution	▪ Switch the Autopilot to Auto to return control to the Autopilot. ▪ Check the power supply to the Autopilot.

bc	
Alarm Log Text	Back-Up
Alarm Description	System has been switched to Backup
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Control System has been switched to Backup. ▪ Cable fault between JCM and one of the Control panels. ▪ Terminating connector missing from connector P1 on the last Control Panel.
Solution	▪ Switch all Control Panels and the JCM to Normal mode. If the system does not switch back to Normal mode, check all cable connections. ▪ Make sure there is a terminating link on the last Control Panel.

bF	
Alarm Log Text	None
Alarm Description	Back Flush gear has been selected. 'bF' flashes for 30 seconds. After 30 seconds 'bF' non flashing and continuous buzzer sounds. Return gears to neutral will cancel 'bF' status warning
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ Gears in Back flush.
Solution	▪ Return Gears to neutral to cancel status warning

bL	
Alarm Log Text	Bearing Level
Alarm Description	The Jet Bearing oil level is too low.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Oil Leak. ▪ Sensor fault. ▪ Cable fault.
Solution	▪ Make sure the bearing oil level is correct - top up if necessary. ▪ Check the Bearing Housing for leaks and repair / replace as necessary. ▪ If the oil level is correct, check the cabling and sensor assembly - replace if necessary.

bP	
Alarm Log Text	Brg Pump Pres
Alarm Description	Bearing cooling pump pressure is low
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Pump motor overload tripped ▪ Faulty pressure switch ▪ No ship power to starter box
Solution	▪ Check pump motor for electrical fault – Replace motor ▪ Check force required to turn pump shaft – Replace pump ▪ Check ship electrical supply at DB board

bt	
Alarm Log Text	Bearing Temp
Alarm Description	The Jet Bearing oil temperature is too high. (Alarm activates at 90º ±5º)
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ Oil Over heating. ▪ Shaft Misalignment ▪ Bearing wear ▪ oil Contamination ▪ Sensor fault. ▪ Cable fault.
Solution	▪ Make sure the bearing oil level is correct - top up if necessary. and allow to cool. ▪ If the oil is overheating refer to the Jet Unit manual for possible causes. ▪ If the oil level and temperature are correct, check the cabling and sensor assembly - replace if necessary.

Co	
Alarm Log Text	V. Compnsation
Alarm Description	A Module has detected an internal fault.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	Module internal fault.
Solution	Replace the Module.

Cn	
Alarm Log Text	CaNbus fault
Alarm Description	A fault on the CAN communication bus has been detected.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ Cabling fault to the module giving the alarm. ▪ Internal fault on the module giving the alarm.
Solution	▪ Switch the Control System power off then back on. ▪ Check cabling to the module giving the alarm. ▪ If no fault is found then replace the module.

d1, d2, d3, d4, d5	
Alarm Log Text	xData?Missing (? = Number indicating which Jet the Control Panel is Connected to)
Alarm Description	No Communication with the Control Panel Module.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Panel not Set-up ▪ Panel module fault. ▪ Cabling fault.
Solution	▪ Set-up the Panel Modules. ▪ Make sure the cables to the Panel Modules are connected correctly. ▪ Find out if a Panel is faulty by swapping the modules around. ▪ Replace faulty Panel Module.

dF	
Alarm Log Text	Param=Default
Alarm Description	Module displaying fault is using default parameters.
Active in Normal	Yes
Active in Backup	No
Possible Cause	Module defaults have been restored.
Solution	Set-up the module causing the alarm.

E0	
Alarm Log Text	MissingMod=?X
Alarm Description	A module is missing ? = Module ▪ J = JCM ▪ E = ECM ▪ P = CPM ▪ A = API X = Module Number
Active in Normal	Yes
Active in Backup	No
Possible Cause	Power loss to module ▪ Blown fuse in JCM. ▪ Cabling fault. Communications lost with module ▪ Cabling fault. ▪ API failure. ▪ Incomplete module Set-Up.
Solution	▪ Replace Internal fuse in the JCM. ▪ Make sure Cables have been connected correctly. ▪ Switch the Control System power off then back on again. If the module is still missing ('*' displayed in the alarm log), replace the Module.

EC	
Alarm Log Text	Config Err=?
Alarm Description	Incompatible configurations on two ECM's ? gives the parameter in conflict: ▪ E = Engine type. ▪ g = Gearbox type. ▪ J = Number of jets. ▪ S = The throttle synchronisation.
Active in Normal	Yes
Active in Backup	No
Possible Cause	Two modules have incompatible settings, may be due to:- ▪ Wrong Initial Set-up. ▪ A replacement module has been incorrectly set-up.
Solution	Set-up the modules again.

Ed	
Alarm Log Text	Duplicate ECM
Alarm Description	Two ECM's have the same Jet Number and ID.
Active in Normal	Yes
Active in Backup	No
Possible Cause	Modules have not been Set-Up correctly may be due to:- ▪ 2 Jets with the same Id. ▪ A replacement module has been incorrectly set-up.
Solution	▪ Perform set-up on each JCM. ▪ Make sure all modules attached to each JCM have been correctly detected.

EE	
Alarm Log Text	EE Corrupt µ
Alarm Description	Faulty memory on the ECM, µ gives the cause: ▪ C = Checksum wrong. ▪ S = Status wrong. ▪ D = Contains defaults. ▪ a = First parameter is invalid. ▪ b = Second Parameter is invalid. c = Third parameter is invalid etc.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Power failure during Set-Up. ▪ Defaults restored and subsequent Set-up not carried out.
Solution	Set-up the module causing the alarm.

EF	
Alarm Log Text	SelFtest Fail
Alarm Description	The ECM start-up self test has failed.
Active in Normal	Yes
Active in Backup	No
Possible Cause	The ECM has detected an internal fault and may be damaged.
Solution	▪ Switch the Control System power off then back on. ▪ Set-up the module. ▪ If the problem continues, replace the module.

Eh	
Alarm Log Text	Too hot
Alarm Description	Engine too hot.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Engine over-heating ▪ Sensor fault.
Solution	▪ Check engine temperature. ▪ Check engine temperature Sensor. ▪ Check engine temperature cabling.

EL	
Alarm Log Text	Local
Alarm Description	ECM is in local control.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	ECM selector switch is set to the LOCAL1 or LOCAL2 position.
Solution	Set the Local/Remote selector switch to REMOTE mode.

En	
Alarm Log Text	Manual
Alarm Description	The engine is in 'local' control.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	ECM is receiving 'engine in Local' signal from the engine
Solution	Set engine to REMOTE mode. (local/Remote switch on ECM)

9c	
Alarm Log Text	Changed state
Alarm Description	There has been an unauthorised gear change.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Gearbox manual shift lever has been moved. ▪ Power failure to gearbox.
Solution	▪ Make sure that the gearbox controls and feedback are operating correctly ▪ Repair any faults found.

9F	
Alarm Log Text	Gear fail
Alarm Description	Incorrect Gearbox feedback signals.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Gearbox failure. ▪ Gearbox feedback signal failure. ▪ Wiring fault between the gearbox and ECM. ▪ ECM fault.
Solution	▪ Make sure that the gearbox is operating correctly. ▪ Make sure that the gearbox feedback signals operate correctly. ▪ Check the wiring between the gearbox and ECM. ▪ Turn the power off and back on. ▪ Replace the module.

9E	
Alarm Log Text	Gearbox fault
Alarm Description	Gearbox fault feedback has activated.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Engine electronics have detected a fault. ▪ Wiring fault between the ECM and the gearbox.
Solution	Refer to the gearbox manufacturer's documentation.

H1, H2, H3, H4, H5, H6	
Alarm Log Text	Helm?SigErr (? = Number indicating at which station the Helm error occurred)
Alarm Description	Secondary helm signal error at Control Station No.1, 2, 3, 4,5 or 6
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Incorrect Control Panel Module set up. ▪ The secondary helm module is incorrectly connected to the Control Panel Module. ▪ The secondary helm module is faulty. ▪ The Control Panel Module is faulty.
Solution	▪ Set-up the Control Panel. ▪ Make sure the cabling is connected correctly ▪ Swap Control Panel Modules, re run the set-up and see if the fault moves with the Panel Module or stays with the Helm Module. ▪ Replace the faulty module as required.

H1, H2, H3, H4, H5, H6	
Alarm Log Text	xHelm SigErr=? (? = Number indicating at which station the Helm error occurred)
Alarm Description	Secondary external helm signal error at Control Station No.1, 2, 3, 4, 5 or 6
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ The jet that this Control Panel connects to derives its signal by combining two helm signals (usual for centre jets). One or both of these signals is out of range. ▪ The secondary helm module is incorrectly connected to the Control Panel Module. ▪ The secondary helm module is faulty. ▪ The Control Panel Module is faulty
Solution	▪ Set-up the Control Panel. ▪ Make sure the Helm Module is connected correctly. ▪ Swap Control Panel Modules, re run the set-up and see if the fault moves with the Panel Module or stays with the Helm Module. ▪ Replace the faulty module as required.

H 1, H2, H3, H4, H5, H6	
Alarm Log Text	Helm?Sig Err (? = Number indicating at which station the Helm error occurred)
Alarm Description	Primary helm signal error at Control Station No.1, 2, 3, 4,5 or 6
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Incorrect Control Panel Module set-up. ▪ The helm module incorrectly connected to the Control Panel Module. ▪ The Helm Module is faulty. ▪ The Control Panel Module is faulty.
Solution	▪ Set-up the Control Panel. ▪ Make sure the Helm Module is connected correctly. ▪ Swap Control Panel Modules, re run the set-up and see if the fault moves with the Panel Module or stays with the Helm Module. ▪ Replace the faulty module as required.

H 1, H2, H3, H4, H5, H6	
Alarm Log Text	xHelm SigErr=? (? = Number indicating at which station the Helm error occurred)
Alarm Description	External helm signal error at Control Station No.1, 2, 3, 4, 5 or 6
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ The jet that this Control Panel connects to derives its signal by combining two helm signals (usual for centre jets). One or both of these signals is out of range. ▪ The secondary helm module is incorrectly connected to the Control Panel Module. ▪ The secondary helm module is faulty. ▪ The Control Panel Module is faulty
Solution	▪ Set-up the Control Panel. ▪ Make sure the Helm Module is connected correctly. ▪ Swap Control Panel Modules, re run the set-up and see if the fault moves with the Panel Module or stays with the Helm Module. ▪ Replace the faulty module as required.

hr (Secondary Hand held Remote) Hr (Primary Hand held Remote)	
Alarm Log Text	Safety Switch
Alarm Description	The Hand Held Remote is missing, or the safety pin has been removed
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Hand Held Remote has been disconnected. ▪ Safety Switch Pin has been removed from the Hand Held Remote.
Solution	▪ Re-connect the Hand Held Remote. ▪ Replace the Safety Switch Pin. ▪ Make sure that the Control Panel indicating the alarm has a Hand Held Remote attached.

J0	
Alarm Log Text	Missing Mod = µX
Alarm Description	A missing module has been detected on this or other JCM's. µ = Module ▪ J = JCM. ▪ E = ECM. ▪ P = CPM. ▪ A = API. X = module number.The Hand Held Remote is missing, or the safety pin has been removed
Active in Normal	Yes
Active in Backup	No
Possible Cause	Power loss to module ▪ Blown fuse in JCM ▪ cabling fault. Communications lost with module ▪ Cabling fault ▪ JCM failure. JCM is in Set-up Incomplete module Set-Up.
Solution	▪ Replace Internal fuse in the JCM. ▪ Make sure Interconnecting Cables have been installed correctly. ▪ Switch the Control System power off then back on. If the module remains missing ('*' displayed in the alarm log) then replace the Module.

J1, J2	
Alarm Log Text	power 1 alarm power 2 alarm
Alarm Description	Primary power supply fault. Secondary power supply fault.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Primary or secondary power supply to the PIM has failed, is too low, or is too high. ▪ Wiring fault in the PIM or between the PIM and the JCM. ▪ Primary or secondary fuse in the JCM has blown.
Solution	▪ Make sure the primary and secondary power supplies to the PIM are in accordance with the specification document. Refer Refer: "MECS Technical Data" on Page 10-41 ▪ If the voltage is correct, then switch the power to the control system off for 1 minute, then back on again.

J4	
Alarm Log Text	RS485 fault
Alarm Description	A fault has occurred on the RS485' network. RS485 is the communication system used between modules in 'Back-Up' operating mode.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	The JCM has lost Backup communication with the JJB this could be due to :- ▪ A cabling fault between the JJB & the JCM. ▪ A JJB failure. ▪ A failure on the JCM.
Solution	▪ If only one module has an RS485 fault then check the cabling to that module and power down the system then power up again. If the problem persists replace the suspect module. ▪ If all panels and the JCM have the fault, power down the system then power up again. ▪ If the problem remains then replace the JJB.

JC	
Alarm Log Text	Config Err =µ
Alarm Description	There are differences in configuration between two or more Jet Control Modules. µ gives the reason: ▪ P = The number of Control Panel Modules varies from Jet to Jet. ▪ J = The 'Number of Jets' parameter is inconsistent.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Incorrect Initial Set-up. ▪ Replacement module with incorrect Set-up
Solution	Make sure that JCM has been configured correctly for the Jet/Controls configuration fitted.

Jd	
Alarm Log Text	Duplicate JCM
Alarm Description	Two JCMs have the same Jet number and ID.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Incorrect Module set-up, e.g. 2 jets with the same ID. ▪ Replacement JCM with incorrect Set-up.
Solution	▪ Set-Up each JCM ▪ Make sure that all modules attached to each JCM have been correctly detected.

JE	
Alarm Log Text	EE Corrupt ?
Alarm Description	Memory fault in the Jet Control Module. '?' gives the cause: ▪ C =Checksum incorrect. ▪ S = Status incorrect ▪ D = Contains defaults. ▪ a = First parameter is invalid. ▪ b = Second parameter is invalid. ▪ c = Third parameter is invalid, etc.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Power failure during Set-Up. ▪ Defaults restored and subsequent Set-Up not done.
Solution	▪ Set-Up the module causing the alarm. ▪ If problem continues, replace the module.

JF	
Alarm Log Text	SelFtest Fail
Alarm Description	The JCM startup self test has failed.
Active in Normal	Yes
Active in Backup	No
Possible Cause	The JCM has detected an internal fault and may be damaged.
Solution	▪ Restore defaults to the faulty module then re-run set-up. ▪ If the problem continues, replace the module.

JL	
Alarm Log Text	Lower duct err
Alarm Description	Lower Reverse Duct positioning fault.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Drive signal fault from JCM. ▪ Drive cable fault from JCM or JJB. ▪ Feedback incorrectly Set-Up in JCM. ▪ Feedback sensor has moved. ▪ Obstruction in the Jet. ▪ Hydraulic failure - pump, oil, valve.
Solution	▪ Set-Up the JCM. ▪ Check the reverse sensor linkage, wiring and supply. ▪ In 'Back-Up', move the Reverse Duct and check that the panel display operates correctly.

JP	
Alarm Log Text	Port strg err
Alarm Description	Port steering Nozzle positioning fault detected.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Drive signal fault from JCM. ▪ Drive cable fault from JCM or JJB. ▪ Feedback incorrectly Set-Up in JCM. ▪ Feedback sensor has moved. ▪ Obstruction in the Jet Unit. ▪ Hydraulic failure - pump, oil, valve.
Solution	▪ Set-Up the JCM. ▪ Check the steering sensor linkages wiring and supply. ▪ In 'Back-Up' move the Steering Nozzle and check that the panel display operates correctly.

Jr	
Alarm Log Text	Rev fbk error
Alarm Description	Reverse feedback fault detected by the JCM.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Feedback incorrectly Set-Up in the JCM. ▪ Feedback sensor has moved. ▪ Feedback sensor wiring fault (JCM - JJB or JJB-sensor). ▪ Feedback sensor fault.
Solution	▪ Set-up the JCM. ▪ Check the reverse sensor linkage, wiring and supply. ▪ In Back-Up, move the Reverse Duct and make sure that the panel display operates correctly - if not then replace the sensor.

JS	
Alarm Log Text	Stbd strg err
Alarm Description	Starboard steering Nozzle positioning fault.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Drive signal fault from JCM. ▪ Drive cable fault from JCM or JJB. ▪ Feedback incorrectly Set-Up in JCM. ▪ Feedback sensor has moved. ▪ Obstruction in the Jet Unit. ▪ Hydraulic failure - pump, oil, valve.
Solution	▪ Set-Up the JCM. ▪ Check the steering sensor linkages wiring and supply. ▪ In'Back-Up move the Steering Nozzle and check that the panel display operates correctly.

Jt	
Alarm Log Text	sTr fbk error
Alarm Description	Steering feedback fault from the Jet into the JCM detected.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Feedback incorrectly Set-up in JCM. ▪ Feedback sensor has moved. ▪ Feedback sensor wiring fault (JCM-JJB or JJB-sensor). ▪ Feedback sensor fault.
Solution	▪ Set-Up the JCM. ▪ Check the steering sensor linkage, wiring and supply. ▪ In 'Back-Up', move the Steering Nozzle and check that the panel display operates correctly - if not then replace the sensor.

Ju	
Alarm Log Text	Raise duct err
Alarm Description	Raise Reverse Duct positioning fault detected.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Drive signal fault from JCM. ▪ Drive cable fault from JCM or JJB. ▪ Feedback incorrectly Set-Up in JCM. ▪ Feedback sensor has moved. ▪ Obstruction in the Jet. ▪ Hydraulic failure - pump, oil, valve.
Solution	▪ Set-Up the JCM. ▪ Check the reverse sensor linkage, wiring and supply. ▪ In 'Back-Up', move the Reverse Duct and check that the panel display operates correctly.

JU	
Alarm Log Text	UnknwnUnit=?X
Alarm Description	An extra module has been detected. ? = module letter, ▪ J = JCM. ▪ E = ECM. ▪ P = CPM. ▪ A = API. X - module number.The Hand Held Remote is missing, or the safety pin has been removed
Active in Normal	Yes
Active in Backup	No
Possible Cause	Occurs when a module is added to the system after the JCM has been Set-Up.
Solution	Re-run Set-Up to configure the new JCM correctly.

o1, o2, o3, o4, o5, o6	
Alarm Log Text	DCM? X Signal-or-DCM? Y Signal (? = Number indicating at which control station the error occurred)
Alarm Description	Manoeuvring Joystick Module signal error at Control Station No.1, 2, 3, 4, 5 or 6
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Incorrect Panel Module set-up. ▪ Faulty Panel Module. ▪ Faulty MJM. ▪ The MJM has not been connected to the panel module correctly.
Solution	▪ Set-up the Panel Module correctly. ▪ Make sure the MJM cabling is connected correctly. ▪ Swap Control Panel Modules, re run the set-up and see if the fault moves with the Panel Module or stays at the MJM. ▪ Replace the faulty module as required.

o1, o2, o3, o4, o5, o6	
Alarm Log Text	xDCM? XSignal-or-xDCM? YSignal (? = Number indicating at which control station the error occurred)
Alarm Description	External Manoeuvring Joystick Module signal error at Control Station No.1, 2, 3, 4, 5 or 6
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ The Jet that this panel is connected to derives it's signal from the port outer jet. This signal is out of range. ▪ The panel module is faulty. ▪ The MJM is faulty. ▪ The MJM has not been connected to the panel module correctly.
Solution	▪ Set-up the port outer Panel Module correctly. ▪ Make sure the MJM cabling is connected correctly. ▪ Swap Control Panel Modules, re run the set-up and see if the fault moves with the Panel Module or stays at the MJM. ▪ Replace the faulty module as required.

oil	
Alarm Log Text	Low OiL Level
Alarm Description	Low JHPU oil level.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ Low JHPU oil level. ▪ Sensor fault. ▪ Cable fault.
Solution	▪ Make sure the JHPU oil level is correct, add oil as required ▪ Look for leaks and rectify if necessary. ▪ Check the operation of the sensor and associated wiring - replace if required.

OP	
Alarm Log Text	JhpuOIL P = H
Alarm Description	High JHPU Oil Pressure. (Alarm activates at 110bar)
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ Pressure relief valve set incorrectly ▪ Blockage ▪ Incorrect oil type ▪ Compensating Circuit damage ▪ Sensor fault. ▪ Cable fault.
Solution	Check above and replace or repair as necessary

OP	
Alarm Log Text	JhpuOIL P = L
Alarm Description	Low JHPU Oil Pressure. (alarm activates at 3bar)
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ Pressure relief valve set incorrectly ▪ Incorrect oil type ▪ Contaminated Oil ▪ JHPU Drive Belts Loose or broken ▪ Compensating Circuit damage ▪ Hydraulics Leak. ▪ Sensor fault. ▪ Cable fault.
Solution	▪ Check the Jet hydraulics for leaks / damage, replace as necessary. Check the JHPU oil level, fill up as necessary. ▪ Check the JHPU drive belts ▪ Check the pressure sensor and cabling, replace as necessary.

Ot	
Alarm Log Text	High OiL Temp
Alarm Description	High JHPU oil temperature. (Alarm activates at 65º)
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ High JHPU oil temperature. ▪ Sensor fault. ▪ Cable fault.
Solution	▪ Check the JHPU oil temperature and level - add oil if necessary and allow to cool. ▪ Investigate the reason for overheating. ▪ If the temperature is satisfactory, check the operation of the sensor and associated wiring - replace if necessary.

o 1, o2, o3, o4, o5,	
Alarm Log Text	DCM1 (2, 3, 4, 5) X Signal DCM1 (2, 3, 4, 5) Y Signal DCM1 (2, 3, 4, 5) Z Signal xDCM1 (2, 3, 4, 5) X Signal xDCM1 (2, 3, 4, 5) Y Signal xDCM1 (2, 3, 4, 5) Z Signal
Alarm Description	DCM1 (2, 3, 4, 5) X Signal missing or Out of Range DCM1 (2, 3, 4, 5) Y Signal missing or Out of Range DCM1 (2, 3, 4, 5) Z Signal missing or Out of Range xDCM1 (2, 3, 4, 5) X Signal missing or Out of Range xDCM1 (2, 3, 4, 5) Y Signal missing or Out of Range xDCM1 (2, 3, 4, 5) Z Signal missing or Out of Range
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ DCM signals out of range ▪ DCM faulty
Solution	▪ Replace DCM

P0	
Alarm Log Text	MissngXMod= µX
Alarm Description	A module has been detected as missing. µ = module letter, ▪ J = JCM. ▪ E = ECM. ▪ P = CPM. ▪ A = API. X = module number.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Power loss to module due to internal fuse in JCM or cabling fault. ▪ Communications lost with module due to cabling fault or panel failure. ▪ Incomplete module Set-Up.
Solution	Identify the missing module (Type, Number and Jet Id) then investigate the reason. This may be due to power failure to the module, cabling problem or module failure. If the module remains missing (* displayed in the alarm log) after a Power Down/Up sequence then the module should be replaced.

P4	
Alarm Log Text	RS485 fault
Alarm Description	A fault has occurred on the RS485 network. RS485 is the communication system used between modules in Back-up operating mode.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	The panel has lost Back-up communication with the JJB this could be due to. ▪ A cabling fault between the JJB & the control panel. ▪ A JJB failure. ▪ A failure on the panel.
Solution	▪ If only one module has an RS485 communication fault, check the cabling to that module. ▪ Switch the system off, then back on again. If the problem persists replace the suspect module. ▪ If all panels and the JCM have the fault, switch the system off, then back on again. ▪ If the problem remains then replace the JJB.

PC	
Alarm Log Text	ctrlCnflict=?
Alarm Description	Panel control conflict, ? gives the reason for conflict.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Control transfer has occurred during a system failure. ▪ Control transfer was interrupted by a system fault e.g. power failure. ▪ A replacement panel has been introduced into the system.
Solution	▪ This fault is self correcting. No action is required apart from checking that the correct station is still in control and locked if desired. ▪ If the problem re-occurs, contact your Hamilton service agent.

PC	
Alarm Log Text	Config Err=?
Alarm Description	There are incompatible configurations set-up on two or more Control Panel Modules. '?' gives the parameter in conflict. ▪ B = The 'Booster Jet' configuration is inconsistent between Control Panel Modules on a Jet. ▪ C = Control Panel Modules at a control station have different 'Helm Curve' settings. ▪ D = Dim Type parameter (factory) is inconsistent. ▪ E = Engine Type parameter is inconsistent. ▪ F = The 'aFt facing station' switch setting is inconsistent between Control Panel Modules at a control station. ▪ G = Gearbox Type parameter is inconsistent between jets. ▪ H = The 'Hand Held Remote' Parameter is inconsistent between Control Panel Modules at a control station. ▪ J= The 'Number of Jets' parameter is inconsistent between Jet Control Modules. ▪ K = The 'Transfer locK' parameter is inconsistent between Control Panel Modules at the same control station. ▪ L = The 'Number of Levers' parameter is inconsistent between Control Panel Modules at a control station. ▪ M = Incompatible settings between control panels for 'Thl Master' parameter. Only port CPM can be Master. ▪ p = The number of Control Panel Modules varies from Jet to Jet. ▪ S = Throttle Sync. ▪ T = Incompatible setting between control panels for 'Throt limit ' parameter. ▪ Z = The 'Non Zero transfer' parameter is inconsistent between Control Panel Modules at a control station.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Initial Setup wrong. ▪ Initial setup of DimType parameter set incorrectly. ▪ Initial setup of 'ThLim master' parameter set incorrectly (factory). ▪ Initial setup of 'Throt limit' parameter set incorrectly. ▪ Initial setup of 'Ttle Sync' parameter set incorrectly. ▪ Initial setup of 'Eng Type' parameter set incorrectly. ▪ Initial setup of 'Gbx Type' parameter set incorrectly. ▪ Replacement Panel Module with incorrect setup.
Solution	Setup the Control panel Modules. or Engine Control Module

Pd	
Alarm Log Text	Duplicate Panel
Alarm Description	There are two Panels with the same Jet Number and ID.
Active in Normal	Yes
Active in Backup	No
Possible Cause	Modules have not been Setup correctly e.g. 2 Jets with the same Id or a control panel has been replaced and not Setup.
Solution	Perform Setup on each JCM and check that all modules attached to each JCM have been correctly detected.

PE	
Alarm Log Text	EE Corrupt
Alarm Description	The memory of the Control Panel Module has invalid information, 'µ' gives the reason: ▪ C = Checksum wrong. ▪ S = status wrong. ▪ D = contains defaults. ▪ a= first parameter is invalid. ▪ b = second parameter is invalid. ▪ c = third parameter is invalid, etc.
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Power failed / removed during Set-Up. ▪ Defaults restored and subsequent Setup not carried out.
Solution	Setup the module causing the alarm.

PF	
Alarm Log Text	SelFtest Fail
Alarm Description	Panel start-up self test failure.
Active in Normal	Yes
Active in Backup	No
Possible Cause	The panel has detected an internal fault and may be damaged
Solution	Restore defaults on the faulty module then rerun setup. If the problem persists replace the module.

PL	
Alarm Log Text	Power Low
Alarm Description	MECS Supply voltages are below normal (Alarm activates at 20VDC
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ Ships chargers switched off. ▪ Cable fault ▪ Faulty Battery.
Solution	▪ Check Chargers ▪ Check Battery state ▪ Power supply cabling ▪ Circuit breakers

PY	
Alarm Log Text	DisplaY fault
Alarm Description	Panel display PCB fault.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	The Display circuit board in the panel is faulty.
Solution	Switch the system off, then back on again. If the fault re-occurs then the panel will need to be replaced.

P-	
Alarm Log Text	None - Status message
Alarm Description	Throttle limit mode enabled
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Take control button of the secondary helm has been pressed to enable Throttle Limit Mode (Throttle limit feature turned on in CPM)
Solution	

P_	
Alarm Log Text	None - Status message
Alarm Description	Throttle limit mode disabled
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Take control button of the secondary helm has been pressed to disable Throttle Limit Mode
Solution	

r0	
Alarm Log Text	RpmFbk OOR
Alarm Description	Jet Shaft Rpm is Out Of Range
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Jet Shaft feedback interface is incorrectly set up ▪ Shaft Rpm Sensor is faulty
Solution	▪ Setup Jet Shaft interface ▪ Replace jet shaft Rpm sensor

ro	
Alarm Log Text	Rolled Over
Alarm Description	Vessel has rolled passed the tilt switch limit
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ Tilt switch contacts closed – normal operation ▪ Tilt switch contacts faulty
Solution	▪ If alarm persists – replace tilt switch

r1, r2, r3, r4, r5, r6	
Alarm Log Text	Revrs ? SigErr (? = Number indicating at which control station the error occurred)
Alarm Description	Primary Reverse Duct Control lever signal error at Control Station
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ The panel module has not been set-up correctly. ▪ The panel module is faulty. ▪ The control lever module is faulty. ▪ The lever module has not been connected to the panel module correctly.
Solution	▪ Setup the panel. ▪ Check control lever module connections. ▪ Swap panel modules, set-up and check if fault moves with the panel module or stays with the control lever module. ▪ Replace the faulty module accordingly.

r 1, r2, r3, r4, r5, r6	
Alarm Log Text	xRevrSigErr=? (? = Number indicating at which control station the error occurred)
Alarm Description	Primary External Reverse Duct control lever signal error at Control Station
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ The Jet that this panel is connected to derives it's signal by combining two Reverse Duct control signals (usual for centre Jets). One or both of these signals is out of range. ▪ A panel module is faulty. ▪ A Reverse Control Lever Module is faulty. ▪ A Reverse Control Lever Module has not been connected to a panel module correctly.
Solution	▪ Setup the panel. ▪ Check the Reverse Control Lever Module connections to the other panels at the same station. ▪ Swap panel modules, set-up and check if fault moves with the panel modules or stays with the Reverse Control Lever Module. ▪ Replace the faulty module accordingly.

r 1, r2, r3, r4, r5, r6	
Alarm Log Text	Revrs B?SigErr (? = Number indicating at which control station the error occurred)
Alarm Description	Secondary Reverse Duct control lever signal error at Control Station
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ The panel module has not been set-up correctly. ▪ The panel module is faulty. ▪ The control lever module is faulty. ▪ The control lever module has not been connected correctly.
Solution	▪ Set-Up the panel. ▪ Check control lever module connections. ▪ Swap panel modules, set-up and check if fault moves with the panel module or stays with the control lever module. ▪ Replace the faulty module accordingly.

rP	
Alarm Log Text	RPM Missing
Alarm Description	The RPM feedback signal from the engine is missing.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ Incorrect set-up. ▪ Faulty connection between the engine and the ECM. ▪ Faulty RPM feedback signal from the engine. ▪ Faulty ECM.
Solution	▪ Check that the ECM is set-up correctly. ▪ Check the RPM connection between the engine and the ECM. ▪ Check for the RPM signal at the engine. ▪ Change the ECM.

S 1	
Alarm Log Text	Simulate Mode
Alarm Description	The JCM is operating in Simulate Mode. The vessel must not be used.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	JCM / CPU switches SW2-3 is ON.
Solution	The switch 'SW2-3 on the CPU circuit board inside the JCM module should be set to OFF.

Sn	
Alarm Log Text	JJB Sensor V
Alarm Description	Jet Junction Box sensor supply failure.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ The primary sensor voltage supply from the JCM has failed. ▪ Cable fault between the JCM & JJB. ▪ JJB circuit failure.
Solution	▪ Measure the sensor supply from the JCM on connector Fb between pin E and pin K and check that it is 5V. ▪ If it is not present, replace the JCM ▪ If it is present then the JJB may be faulty

SP	
Alarm Log Text	disp Spi fail
Alarm Description	Communications failure between the two circuit boards within the control panel.
Active in Normal	Yes
Active in Backup	Yes
Possible Cause	▪ The Panels CPU card has a fault. ▪ Faulty connection between the CPU and display cards in the panel.
Solution	This fault indicates a problem within the panel on which the alarm is displayed. If the problem is not rectified by turning off and back on then the panel should be replaced.

t1, t2, t3, t4, t5, t6	
Alarm Log Text	Thrtl? SigErr (? = Number indicating at which control station the error occurred)
Alarm Description	Throttle lever signal error at Control Station
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ The panel module has not been setup correctly. ▪ The panel module is faulty. ▪ The control lever module is faulty. ▪ The control lever module has not been connected to the panel module correctly.
Solution	▪ Set-Up the panel module correctly. ▪ Check control lever module connections. ▪ Swap panel modules, set-up and check if fault moves with the panel modules or stays with the control lever module. ▪ Replace the faulty module accordingly.

t1, t2, t3, t4, t5, t6	
Alarm Log Text	xThrtSigErr=? (? = Number indicating at which control station the error occurred)
Alarm Description	External throttle lever signal error at Control Station
Active in Normal	Yes
Active in Backup	No
Possible Cause	▪ The jet that this panel is connected to derives its signal by combining two throttle control signals (usual for centre Jets). One or both of these signals is out of range. ▪ A panel module is faulty. ▪ A throttle control lever module is faulty. ▪ A throttle control lever module has not been connected to a panel module correctly.
Solution	▪ Set-up the panel. ▪ Check throttle control lever module connections to the other panels at the same station. ▪ Swap panel modules, set-up and check if fault moves with the panel modules or stays with the throttle control lever module. ▪ Replace the faulty module accordingly.

Dynamic Positioning Interface Fault Codes

The following alarm codes apply when operating with a Dynamic Positioning System.

Alarm Codes

dE	
Alarm Log Text	EE corrupt =m
Alarm Description	Memory failure in the DPI Module, 'm' gives the reason: ▪ C= checksum wrong, ▪ S= status wrong, ▪ a = first parameter is invalid. ▪ b = second parameter is invalid, etc.·
Possible Cause	▪ Power failure during Setup.· ▪ Defaults restored and subsequent Setup not carried out.
Solution	Set-up the DPI module before using the system.

dF	
Alarm Log Text	Param Default
Alarm Description	Default parameters are being used by the DPI.
Possible Cause	Internal fault in the DPI.
Solution	Turn the power off then back on. ▪ Set-up the module. ▪ If the problem persists replace the module.

dF	
Alarm Log Text	selFtest fail
Alarm Description	The DPI has failed the power on self test.
Possible Cause	The DPI has detected an internal fault.
Solution	▪ Turn the power off and then back on. Setup the module. ▪ If the problem persists replace the module.

d0	
Alarm Log Text	MissngMod = mX
Alarm Description	A DPI module has detected a missing module on the same jet. m - module letter, ▪ J = JCM. ▪ E = ECM. ▪ P = CPM. ▪ A = API. X - module number.
Possible Cause	▪ Power loss to module due to internal fuse in JCM or cabling fault. ▪ Communications lost with module due to cabling fault or JCM failure. ▪ JCM is in Setup. ▪ Incomplete module Setup.
Solution	Identify the missing module (Type, Number and Jet Id) then investigate the reason. May be due to power failure to the module, cabling problem or module failure. If the module remains missing ('*' displayed in the alarm log) after a power down/up sequence then it should be replaced.

dO	
Alarm Log Text	MissngXMod = ?X
Alarm Description	A DPI module has detected a missing module on another jet. ? - module letter, ▪ J = JCM. ▪ E = ECM. ▪ P = CPM. ▪ A = API. ▪ D = DPI. X - module number..
Possible Cause	▪ Power loss to module due to internal fuse in JCM or cabling fault. ▪ Communications lost with module due to cabling fault or JCM failure. ▪ JCM is in Set-Up. ▪ Incomplete module Set-Up.
Solution	Identify the missing module (Type, Number and Jet Id) then investigate the reason. May be due to power failure to the module, cabling problem or module failure. If the module remains missing ('*' displayed in the alarm log) after a power down/up sequence then it should be replaced.

dd	
Alarm Log Text	Duplicate DPI.
Alarm Description	The system thinks there are two DPI modules connected to the same jet.
Possible Cause	Modules have not been Set-Up correctly e.g. 2 Jets with the same Id or a DPI has been replaced and not Set-Up.
Solution	▪ Setup each JCM. ▪ Check that all modules attached to each JCM have been correctly detected.

dc	
Alarm Log Text	Config Err = ?
Alarm Description	A DPI module has detected a missing module on the same jet. m - module letter, ▪ J = JCM. ▪ E = ECM. ▪ P = CPM. ▪ A = API. X - module number.
Possible Cause	▪ Power loss to module due to internal fuse in JCM or cabling fault. ▪ Communications lost with module due to cabling fault or JCM failure. ▪ JCM is in Setup. ▪ Incomplete module Setup.
Solution	Identify the missing module (Type, Number and Jet Id) then investigate the reason. May be due to power failure to the module, cabling problem or module failure. If the module remains missing ('*' displayed in the alarm log) after a power down/up sequence then it should be replaced.

dc	
Alarm Log Text	Mode Conflict
Alarm Description	DP mode is enabled on DPI channels A and B at the same time.
Possible Cause	▪ Fault in the DP system, DP mode selector switch or wiring. ▪ Fault in DPI module PCB.
Solution	▪ Check the DP system, interface wiring and switch(es) for faults. ▪ Replace DPI module if found faulty.

cn	
Alarm Log Text	caNbus fault
Alarm Description	A fault on the CAN bus has been detected.
Possible Cause	▪ Cabling fault to the DPI module. ▪ Circuit failure in the DPI module.
Solution	▪ Turn the power off and then back on again (this resets the system). ▪ Check the cabling to this module. ▪ If no fault is found then replace the module.

dt	
Alarm Log Text	DPA Thrust Sig DPB Thrust Sig
Alarm Description	The thrust signal from the DP system is out of range on channel A or B.
Possible Cause	▪ Wiring fault between the DP system and DPI module. ▪ DP system not correctly calibrated. ▪ Fault in the DP system. ▪ Fault in the DPI module A-D circuitry.
Solution	▪ Check the interface wiring. ▪ Check the voltage range of the thrust command, recalibrate the DP system and/or DPI module as necessary. ▪ Repair the DP system or replace DPI module if faulty.

dA	
Alarm Log Text	DPA Azimuth DPB Azimuth
Alarm Description	The azimuth signal from the DP system is out of range on channel A or B.
Possible Cause	▪ Wiring fault between the DP system and DPI module. ▪ DP system not correctly calibrated. ▪ Fault in the DP system. ▪ Fault in the DPI module A-D circuitry.
Solution	▪ Check the interface wiring. ▪ Check the voltage range of the thrust command, recalibrate the DP system and/or DPI module as necessary. ▪ Repair the DP system or replace DPI module if faulty.

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8 - Maintenance

In This Section

General

This Maintenance Schedule is for normal operating conditions.

If the Jet Unit is operated where the Control Equipment will be exposed to salt spray (e.g. An open vessel). Linkages should be greased on a weekly basis.

Hydraulic Faults

The majority of hydraulic failures are due to oil contamination.

It is very important that the oil is filtered when filling the JHPU.

All dismantling must be done by qualified personnel following the rules below:

- Immobilize the vessel to prevent uncontrolled movements.
- Maintenance must be carried out with the valves at room temperature.
- Before opening the hydraulic circuit, make sure the system is off and depressurised.
- Before doing any maintenance, make sure that the Reverse Duct is in the fully down position.
- Before disconnecting any electrical wiring, make sure that the power is off.
- Cleanliness is of the utmost importance. Dirt or foreign material in the hydraulic system can cause serious damage or incorrect operation. Always work in a clean environment.
- Before disconnecting hoses, thoroughly clean the outside of the fittings to prevent dirt from entering the ports.
- When removing hoses, always make sure that the ports and pipes are properly plugged.
- Use plenty of oil absorbent cloth to prevent contaminating surrounding areas.
- All seals and O-rings removed or disturbed during dismantling should be replaced.
- Recommendations for Oil and Filter inspections and changes shown in this Manual are to be strictly adhered to.
- If the vessel is used in severe conditions where the oil is likely to become contaminated, the oil and oil filter should be replaced at more frequent intervals.
- Always check the oil level in the reservoir and the pump case whenever oil is removed from the hydraulic system.
- Unless otherwise specified, lubricate stainless steel hydraulic fittings with hydraulic oil or general purpose grease (e.g. Accrolube®) Refer: "Recommendations for Lubricants and Oils" on Page 10-18

Deck Mounted Control Stations

Regularly check seals and protective housings on any deck mounted modules.

Preservation: Pre Installation

To prevent damage or deterioration, provide the following storage requirements:

Coat all exposed steel parts (except stainless steel) with a thin layer of rust preventative oil.

To protect hydraulic fittings:

- Cover with oil impregnated corrosion protection tape.

Or

- Use a recognised corrosion protection spray.

In cold environments, water operated oil coolers must be drained of coolant water to prevent freezing.

Anti fouling Paints

Do not use Copper Oxide based anti-fouling paints.

Do not paint over the Anodes.

Anti-Seize Compounds

Do not use anti-seize compounds which are based on graphite, nickel or copper flakes - these will cause corrosion.

Anti-seize compounds, usually containing zinc flakes, are available for aluminium.

8

Servicing Intervals

Vessel usage is assumed to be 2000 Operational Hours per year.

The frequency of the following service items may be varied to suit actual operating conditions.

MECS Service Interval Table

Item	Actions	1st 5 Hours	Daily	100 Hours	500 Hours	Monthly	3 Months	1000 Hours	2000 Hours	5000- Hours	
JHPU Oil Filter	Replace	■							■		Refer: "Oil Filter" on Page 8-4
JHPU Oil	Check level & condition		■								Refer: "JHPU Oil" on Page 8-4
JHPU Reservoir Filler/Breather	Clean or Replace							■			Refer: "JHPU Reservoir Filler/Breather" on Page 8-4
Oil Coolers	Visually Examine	■				■					Refer: "Oil Coolers" on Page 8-4
Feedback Sensors	Visually Examine					■					Refer: "Feedback Sensors" on Page 8-4
V-Belts	Check Tension	■				■					
JHPU	Inspect and repair as necessary									■	Refer: "JHPU Examination" on Page 8-6
System Hoses	Visually Examine	■				■					Refer: "System Hoses" on Page 8-6
Normal Operation	Test Normal Operation					■					Refer: "Normal Operation" on Page 3-24
Backup Control	Test Backup Control		■								Refer: "Back-up Operation" on Page 3-32
Joystick Helm Module	Visually Inspect the Rubber Boot					■					Refer: "Joystick Helm Module" on Page 8-6
Control Panel Module	Visually Inspect the Rubber Boot						■				Refer: "Control Panel Module" on Page 8-7
Cables & Connectors	Visually Inspect							■			Refer: "Cables and Connectors" on Page 8-7

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Servicing Details

JHPU Oil

Visually inspect oil Level and condition daily. Refer: "Recommendations for Lubricants and Oils" on Page 10-18

The oil used in the JHPU System should meet the requirements of ISO 4406 with a maximum level of contamination of -/18/15

- Check the oil level on the JHPU Filler Cap/dipstick.
- Top up if necessary with the correct grade oil.
- Visually inspect the condition of the oil and replace if discoloured, contaminated or smells unusual.
- Filter the oil as it is added to the JHPU.
- Use only recommended oils

Replace after the first 5 hours of operation, then every 2000 hours.

- Put a suitably sized container bellow the JHPU Tank Drain Plug.
- Remove the plug and let the oil to flow into the container.
- Refit the drain plug and tighten.
- Fill the JHPU to the *Max* mark on the dipstick with the correct grade of oil.
- Discard the waste oil in accordance with current regulations.

Alternatively:

- Use the oil filler hole to suck oil from the reservoir using an "Oil Retrieval System"

Oil Filter

Renew after the initial first 5 hours of running and then every 2000 hours.

- Remove the Filter Lid and replace the Filter Element.

The Filter Lid is under tension from the element retaining spring. Care should be take when removing.

- Replace the Lid, taking care not to damage the O-Ring.
- Tighten the Filter Lid Retaining Screws.

Oil Coolers

Visually Inspect after the first 5 hours of running and then Monthly.

- Look for leaks or damage at the sealing face of the Oil Cooler and Oil Cooler Cover Plate.
- Replace the Cover seal if leaking.
- Look for leaks at the hose connections.

Feedback Sensors

Visually inspect all feedback sensors Monthly.

- Look for loose or damaged connections.
- Replace Sensor if a fault is suspected.

JHPU Reservoir Filler/Breather

Clean every 1000 hours.

- Remove the Filler/Breather from the JHPU Reservoir and rinse in white spirits.
- If the Filler/Breather looks damaged it should be replaced.

The Filler/Breather should be replaced after 5000 operating hours or once a year whichever occurs first.

JHPU V-Belts

Check the V-Belt condition and tension monthly.

Spare V-Belts

Spare V-Belts can cause a potential hazard if not properly secured.

Make sure that spare V-Belts are fastened securely to the Jet Unit and do not come loose during vessel operation.

The Coupling will have a set of spare V-Belts and a label attached.
Make sure that the Mainshaft passes through the V-Belts. This will allow the spare V-Belts to be fitted without disconnecting the Driveshaft from the Coupling.

Checking V-Belt Tension

- Correct Belt tension is achieved when a load of 2.8 kg applied to each Belt at mid span causes a deflection of 3 mm.
- Re-tensioning is required when a load of 1.9 kg or less causes the same 3 mm deflection.

To check belt tension use a tension gauge, or as a guide:

- Grip one of the Belts at mid point and attempt to twist 90°.
- If the Belt rotates beyond 90°, re-tensioning is required.

If the Belt does not rotate to 90°, then the tension is too tight. Re-adjust the Belt tension.

Over tightened V-Belts will cause reduced JHPU Bearing life.

Check V-Belt Condition

Check the belts for cracks, frayed areas, cuts or unusual wear patterns.

Replace Belts if any sign of deterioration is found.

Check to see if the belts become excessively hot. V-Belts generate heat during operation but they should not be too hot to touch.

If excessively hot, the V-Belt tension could be incorrect or they may require replacement.

JHPU Examination

Carry out a complete inspection of the JHPU every 5000 Hours. Look for deterioration and wear and overhaul if necessary Refer: "JHPU Examination and Repair" on Page 9-9.

System Hoses

Visually inspect the system hoses after the first 5 hours of operation and then every 1000 hours.

Look for the following:

- Wear and chafing caused by excessive vibration.
- Leaks in hoses or connections.
- Loose hydraulic connections.

Recondition or repair as necessary.

MECS Servicing Details

Maintenance

If MECS modules are exposed to salt spray, rinse the modules with clean fresh water at the earliest opportunity.

Salt deposits left to build up on the modules can damage seals and accelerate corrosion.

When changing module light bulbs, ensure that the O-Ring Seals are in good condition and are lightly lubricated with silicone grease.

Make sure that control modules are firmly bolted to the console and that the mounting gaskets are sealing correctly.

Normal Operation

Test *Normal* mode operation for each Jet Unit.

This should be done before operating the vessel.

Refer: "Normal Operation" on Page 3-24

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Backup Operation

Test *Backup* Mode operation for each Jet Unit.

This should be done before operating the vessel.

Back-up mode must be checked every time the vessel is operated.

Refer: "Back-up Operation" on Page 3-32

Joystick Helm Module

Visually inspect the rubber boot every month

- Replaced if there are any signs of damage.

This module relies on the rubber boot to keep the joystick waterproof.

This is very importance for Deck Mounted Equipment.

Control Panel Module

Visually inspect the Jogstick rubber boot every month.

- Replaced if there are any signs of damage.

This module relies on the rubber boot to keep the Control Panel waterproof.

This is very importance for Deck Mounted Equipment.

Cables and Connectors

Visually inspect electrical cables and connections every 1000 hrs.

Make sure that:

- All connectors and earth bonding wires are securely connected.
- All cables are attached to a fixed object near the connectors. This will prevent unnecessary strain on the connectors.
- Spray the outside of all connectors with electrical grade silicone moisture repellent.

Threaded Fasteners

Tightening Torques

Ensure all threaded fasteners are tightened to the correct torque as shown in the Appendix and any relevant assembly drawing.

Refer: "Threaded Fastener Tightening Torques" on Page 10-12

Thread Locking Agents

Some fasteners require thread locking agents to prevent loosening.

- Most applications are described in the Loctite® Application Guide Refer: "Loctite Application Guide" on Page 10-3.
- Special applications will be shown on the relevant Assembly Drawings.

Tools

The following tools and accessories are required to maintain the Control System.

Screwdrivers	Flat Blade & posidrive
Spanners	Metric and Imperial
Allen Keys	Metric and Imperial
Thread Tape	
Loctite	Refer Loctite® application guide
Silica Gel	
Electrical Contact Cleaner and Lubricant	
Silicone Grease.	

Recommended Oils and Lubricants

Refer: "Recommendations for Lubricants and Oils" on Page 10-18

Anti-Seize Compounds

Do not use anti-seize compounds which are based on graphite, nickel or copper flakes - these will cause corrosion.

Anti-seize compounds, usually containing zinc flakes, are available for aluminium.

Do not use brake fluid or heavier viscosity oils

8

9 - Overhaul

In This Section

9

Steering Cylinder Overhaul

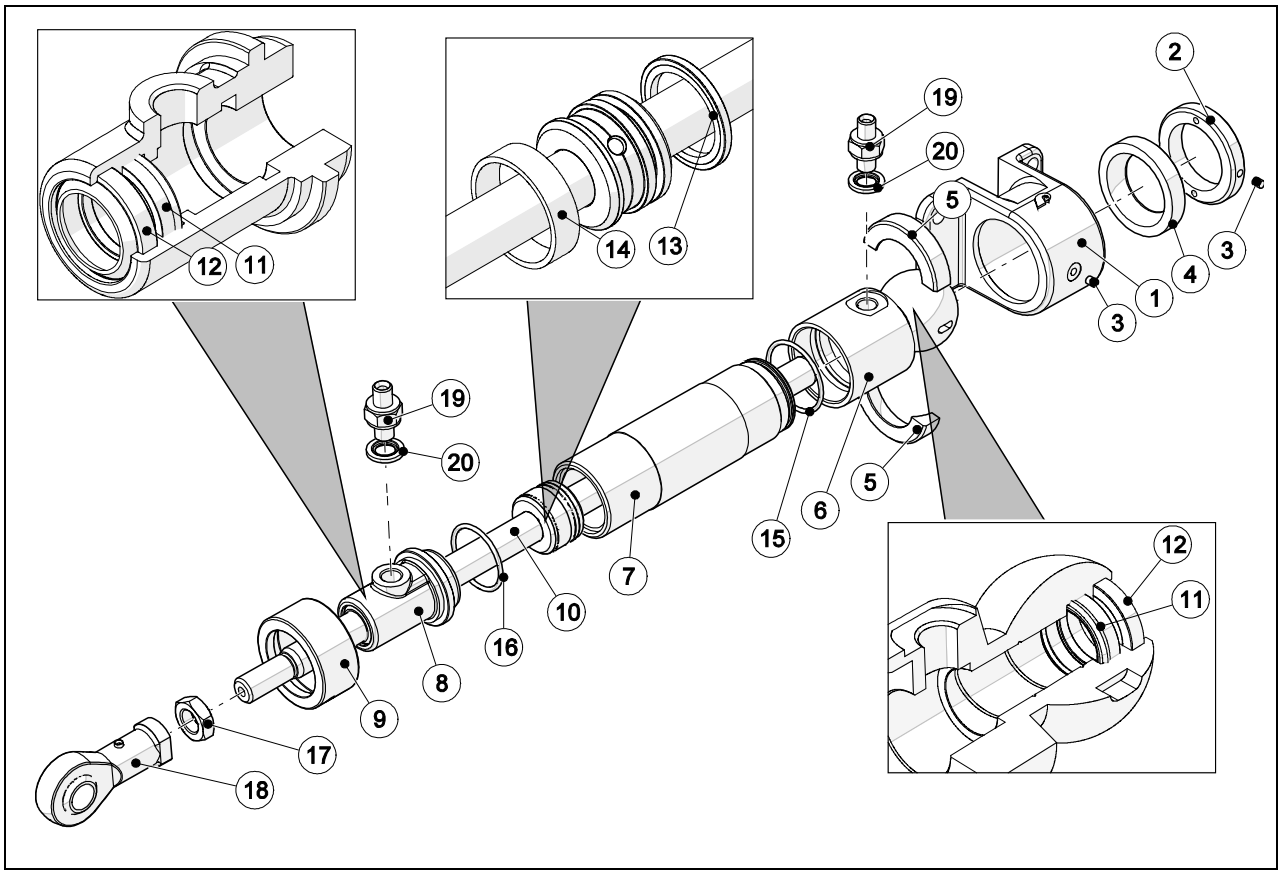


Figure 41: Steering Cylinder Assembly

1	108645	Cylinder Mount	11	064954	Shaft Seal
2	108646	End Cap	12	061493	Shaft Wiper
3	108647	Plug (Nylon)	13	061494	Piston Seal
4	108650	Spherical Bush	14	108841	Piston Wear Strip
5	108665	Spherical Bush (2 Piece)	15	061498	O-Ring
6	108651	Backhead	16	061497	O-Ring
7	108652	Cylinder (120mm Stroke)	17	201323	M16 Half Nut
8	108654	Fronthead	18	201460	Rod End
9	108655	Fronthead Cap	19	205062	¼BSPPx¼BSPP Nipple
10	108658	Shaft Assembly (120mm Stroke)	20	201766	¼" Bonded Seal

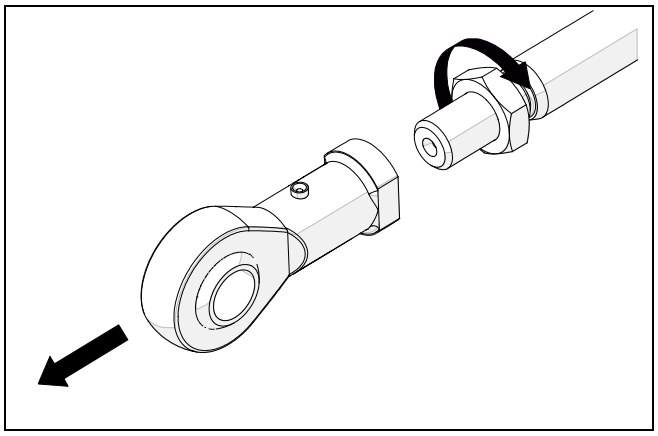
A replacement Seal Kit is available from C.W.F.Hamilton Ltd
Part # 203086

The overhaul of hydraulic equipment must be done by suitably qualified personnel in a clean workshop environment.

To make refitting easier, the Seals can be softened in hot oil (Maximum temp 100°C).

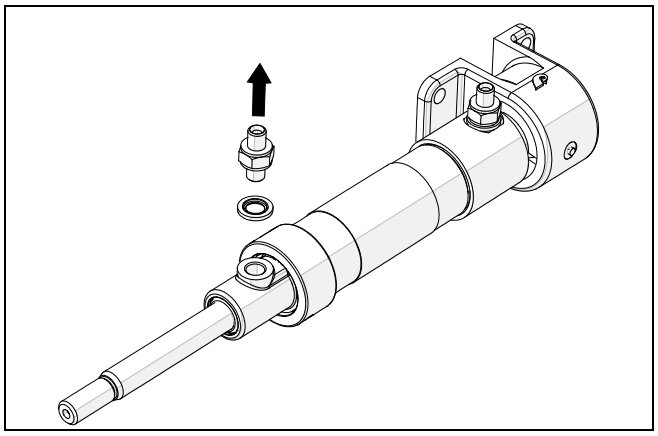
Do not fold the Seals, collapse as shown below.

Dismantle the Cylinder



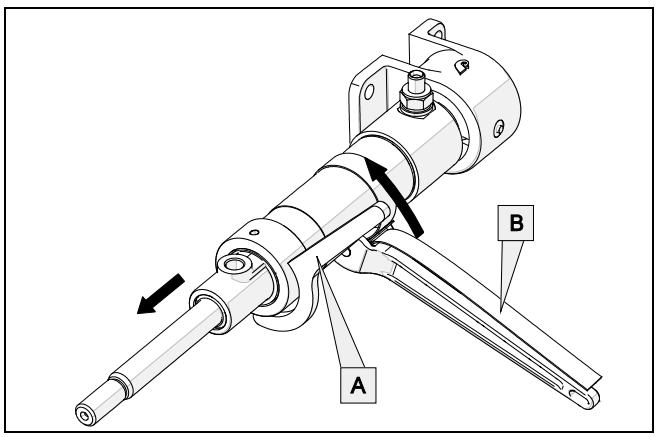
Loosen the locknut and unscrew the Rod End from the Shaft Assembly.

Remove the Locknut.

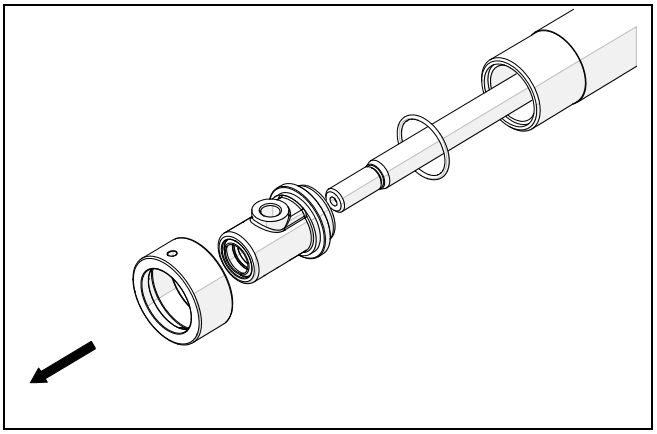


Remove the Front head Nipple and Bonded seal

The Backhead Nipple only needs removal if being replaced.

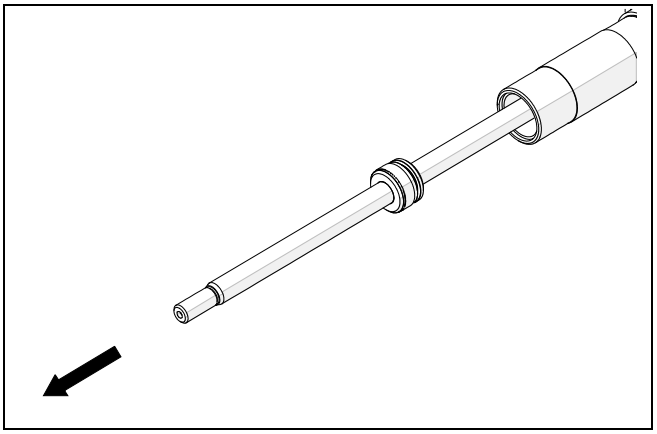


Using a suitable sized "C" or "Hook" spanner [A] and a Strap Wrench [B], unscrew the Fronthead Cap.

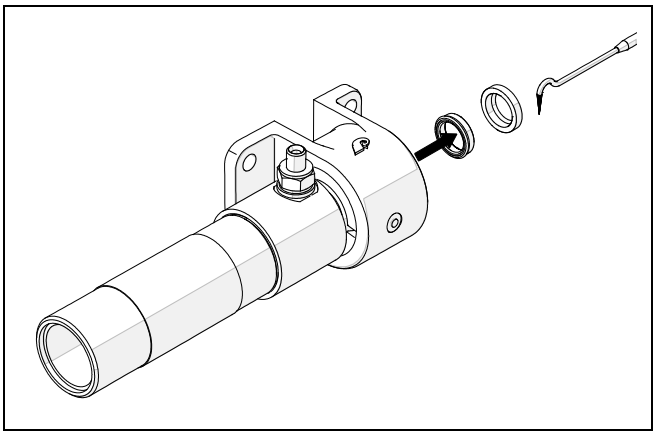


Remove the Front Head Cap and Front Head.

Remove and discard the Front Head O-ring.



Withdraw the Mainshaft Assembly from the Cylinder Barrel.



The cylinder barrel can remain attached to back head.

Use a seal pick to remove the Fronthead, Backhead and Piston seals.

Discard all Seals, Wear and O-Rings.

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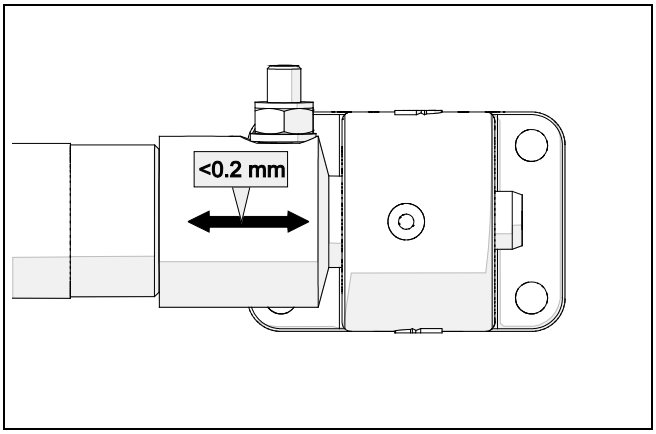
Checking Cylinder for Wear

Check:

- Front and Back heads for damage or wear.
- Excessive movement between the backhead and the Mounting Bracket.
- The Main Shaft assembly for Damage or Wear. (Do not remove the Piston from the Mainshaft. Replace the complete Mainshaft assembly if necessary).
- The Cylinder bore for wear or scoring.

Clean all parts and replace all Seals, O-rings and Wear rings upon reassembly.

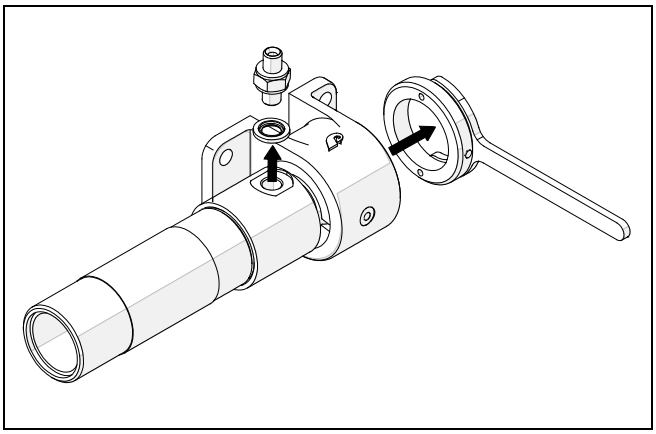


There must be no more than 0.2mm of play between the Backhead and the Cylinder Mount.

Minor play or wear can be adjusted by tightening the end Cap.

If there is excessive movement, remove the backhead and check the ball and spherical bush for wear.

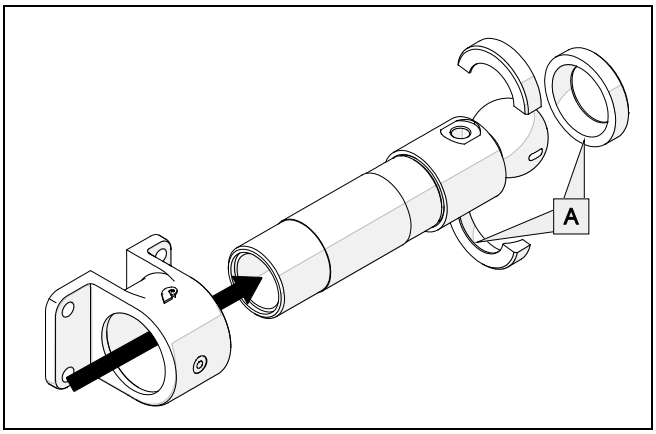
Remove the Backhead



To remove the Backhead

Remove the Backhead Nipple and Bonded Seal

Unscrew the End Cap.



Push the Cylinder & Backhead back through the Mounting block.

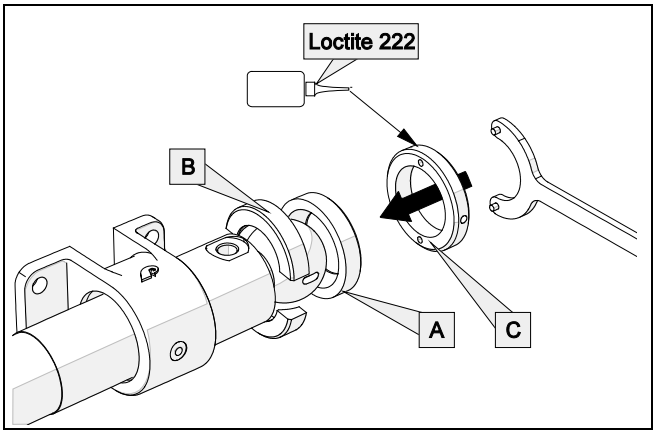
Remove the Spherical Bush [A]

Check the Backhead ball and Spherical Bush for excessive wear or scoring.

Replace if necessary.

9

Tightening the Backhead



To refit the Backhead

Fit the two piece Spherical Bush [B] around the neck of the Backhead Ball.

Feed the Cylinder and Backhead with Spherical bush halves attached, through the Mounting Block.

Fit the one piece spherical bush [A] into the end of the Mounting Block. Make sure the spherical face of the bush sits against the Backhead ball.

Clean all old Loctite from the End cap [C].

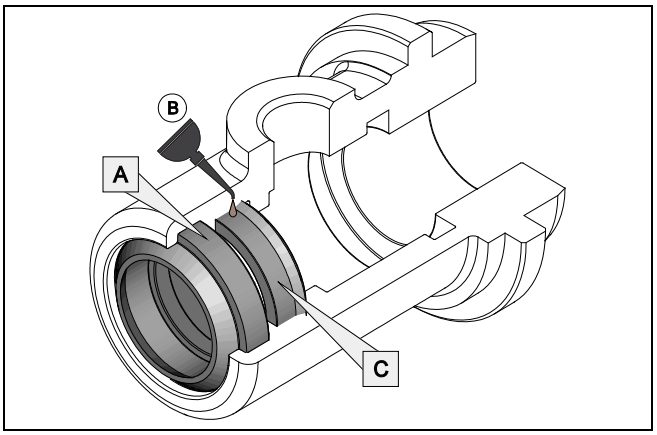
Apply Loctite 222 to the End cap Threads

Re-fit the End Cap to the Cylinder Mounting Bracket

Tighten the End Cap until the Cylinder will not drop under its own weight but can still be moved by hand.

Reassemble the Cylinder

Fronthead Seals

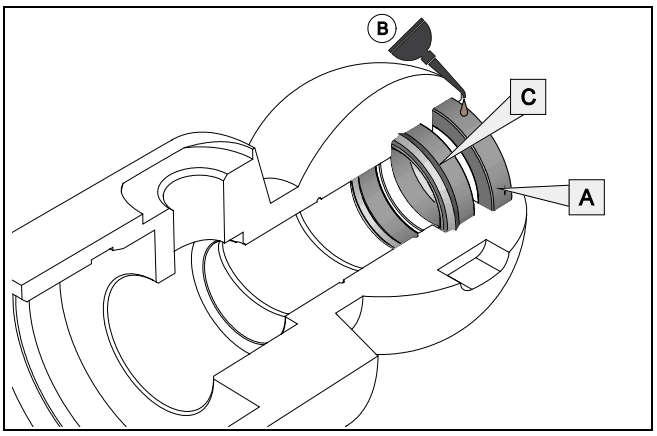


Apply a light coating of hydraulic oil (B) to the seals.

Refit the new Wiper Seal [A], (fit with the lip facing away from the Cylinder)

Refit the new Shaft Seal [C], (fit with the lip facing the Cylinder)

Backhead Seals

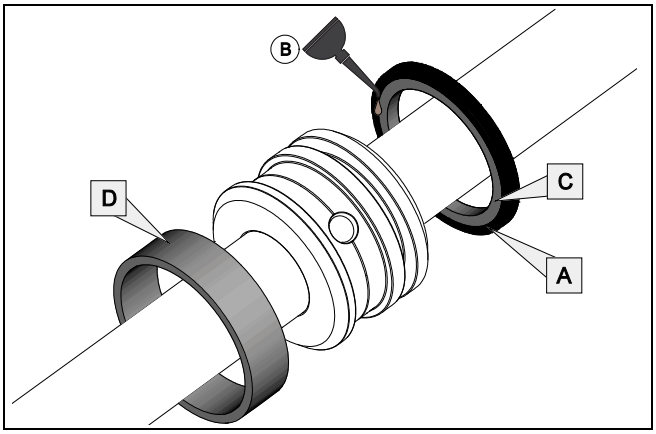


Apply a light coating of hydraulic oil (B) to the seals.

Refit the new Wiper Seal [A], (fit with the lip facing away from the Cylinder)

Refit the new Shaft Seal [C], (fit with the lip facing the Cylinder)

Piston Seals

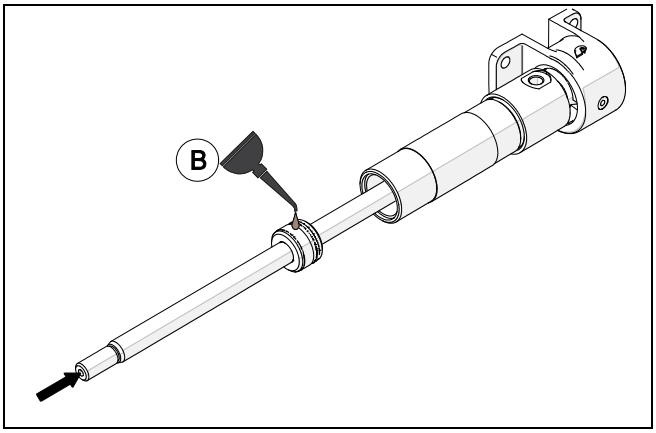


Apply a light coat of hydraulic oil (B) to the Piston seals

Fit the square seal [C] into the seal groove. Make sure the seal is not twisted.

Fit the Outer (red) Ring [A] on top of the Square seal.

Fit the Wear Ring [D] to the groove in the Piston.

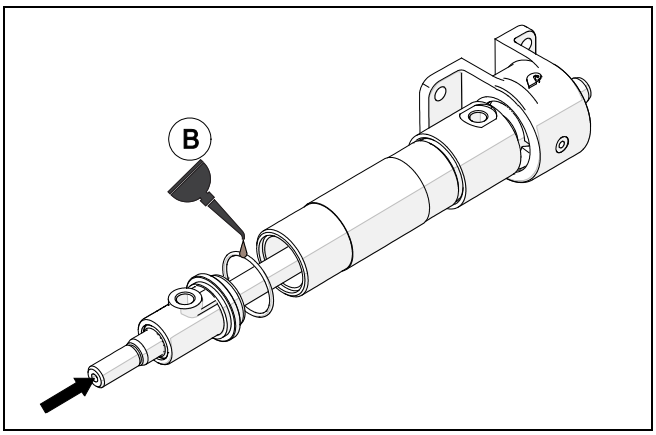


Smear a light coating of hydraulic oil (B) over the piston and mainshaft.

Carefully feed the non threaded end of the Mainshaft through the Cylinder Barrel and Backhead.

Take care not to damage or dislodge the seals in the Backhead.

Fed the mainshaft until the Piston is completely inside the Cylinder Barrel.

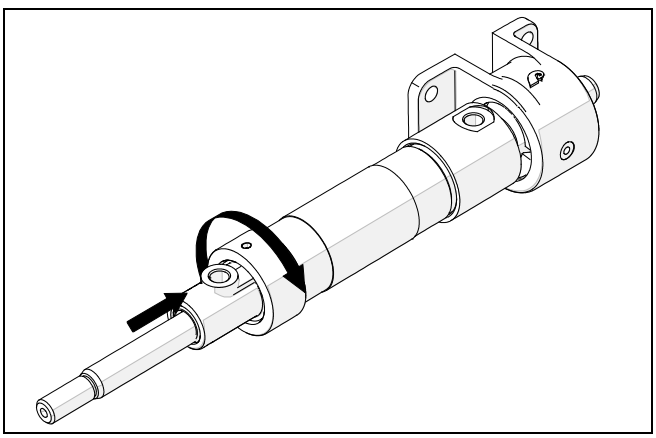


Apply a light coat of hydraulic oil (B) to a new Fronthead O-Ring.

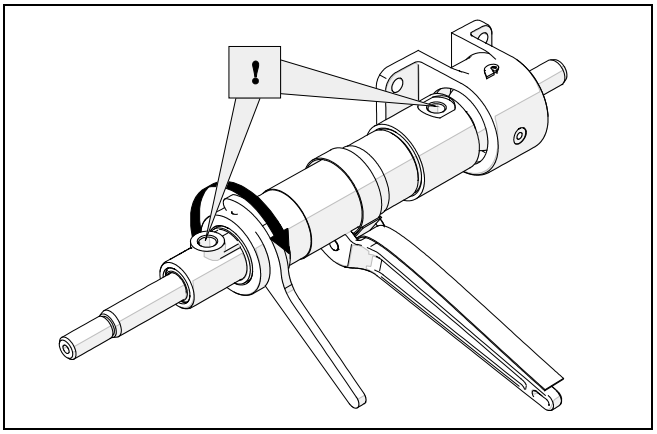
Fit the O-Ring to the Front Head.

Carefully feed the Fronthead over the threaded end of the mainshaft.

Take care not to damage or dislodge the seals in the Fronthead.

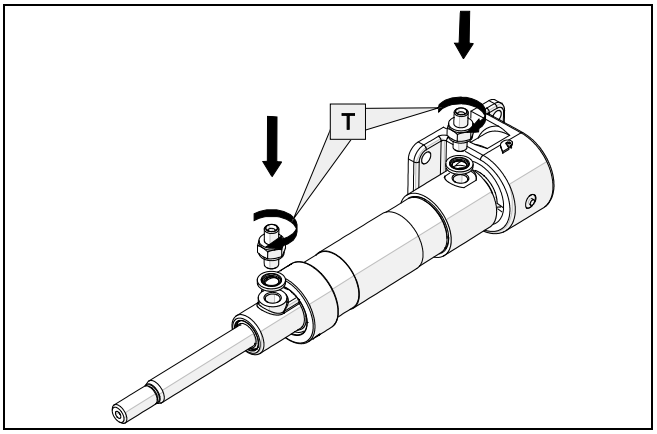


Screw the Fronthead Cap onto the cylinder.



Tighten the Front and Backheads firmly

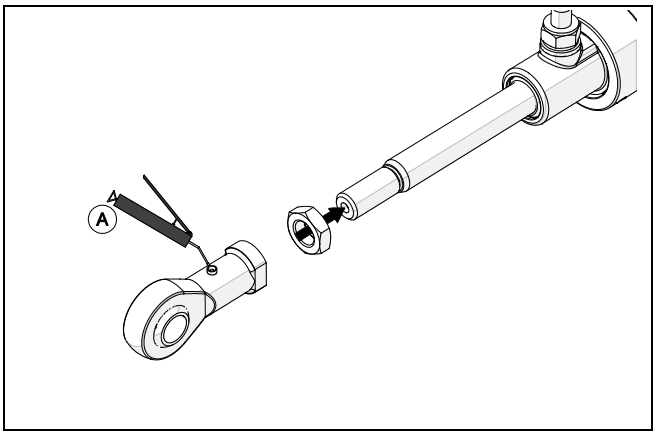
Make sure the Nipple holes are aligned in the same plane



Refit the Bonded Seals and Nipples to the Front head and if necessary the Backhead

Tightening Torque:

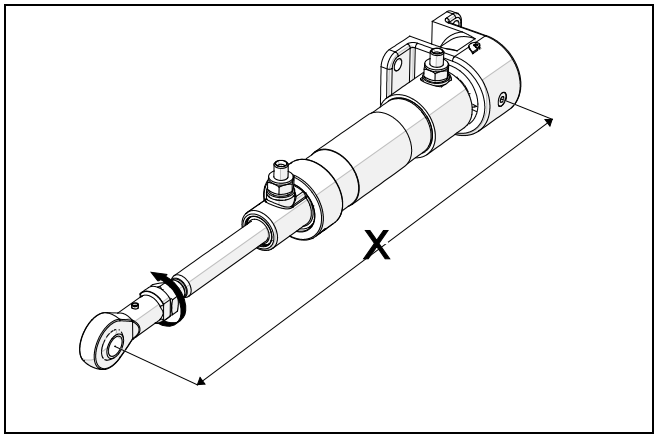
T = 35 N · m (26 lbs ft)



Refit the Rod end to the Mainshaft.

Grease (A) the Rod End Ball via the hole in the Rod End.

9



- Set the distance from the centre of the cylinder mount to the centre of the Rod End ball.

	Dim X
Open	462 mm ± 2 mm
Closed	342 mm ± 2 mm

- Tighten the Locknut

On Completion of the overhaul and before refitting to the vessel, the Cylinder must be pressure tested to 2250 psi in both directions

JHPU Examination and Repair

During overhaul, all parts of the Hydraulic Power Unit should be checked for Wear or damage and cleaned prior to re-assembly.

The Oil Pumps should be tested by an authorised dealer to confirm their reliability until the next scheduled service.

Tools

The following tools are required to do maintenance on the JHPU.

Allen Keys	Metric A/F	2.5mm, 4mm, 5mm, 6mm
	Imperial A/F	1/8", 1/4"
Spanners	Metric A/F	10mm, 12mm, 17mm, 18mm, 19mm, 22mm, 25mm, 32mm
	Imperial A/F	5/8", 13/16", 7/8", 1 1/16", 1 1/4"

To remove the JHPU pulley bearings:

- Circlip pliers
- Manual Press
- Oven (To refit Bearing)

JHPU Removal

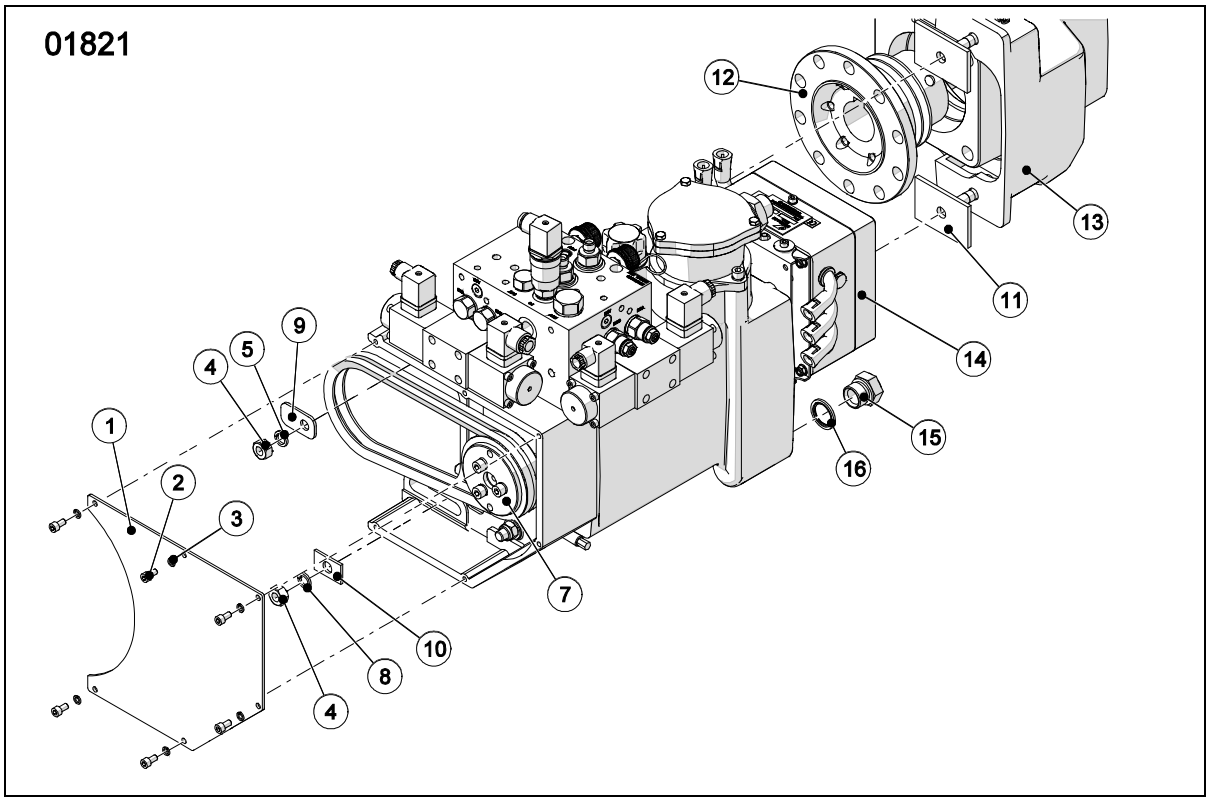


Figure 42: Jet Mounted Hydraulic Power Unit

1	107252	Belt Guard	9	113037	Mount Washer (Top)
2	030829	M6x12 Cap Screw	10	107144	Rectangular Washer
3	201392	M6 Spring Washer	11	Various	Shims
4	201332	M12 Nyloc Nut	12	Various	Coupling
5	109428	Belt Tensioner	13	Various	Bearing Housing
6	Various	V-Belts	14	CTITF03004	Jet Unit Junction Box
7	Various	Driven Pulley	15	205055	Plug 3/4 BSPP
8	201396	M12 Spring Washer	16	201769	Bonded Seal

Drain the oil from the Hydraulic System

Refer: "JHPU Oil" on Page 8-4

9

Remove the JHPU from the Jet Unit

Unplug the connectors from the Reverse and Steering Solenoid Valves.

Unplug the Cables from the Jet Junction Box.

Disconnect and plug the hydraulic hoses to the Oil Cooler and Hydraulic Cylinders.

Remove Belt Guard.

Loosen the two Front Plate Mounting Nuts.

Unscrew the Belt Tensioner and slide the JHPU towards the Jet Unit Coupling.

Remove the V-Belts from the Driven Pulley.

Remove the upper and Lower Mounting Nuts and Washers.

Do not lose any of the alignment Shims located between the JHPU and the Bearing Housing. Record the quantity and size of the Shims to aide with reassembly.

Remove the JHPU complete with the Jet Junction Box from the vessel for overhaul.

Remove and Inspect Level and Temperature Sensors

Only remove the JHPU Oil Temperature or Oil Level sensor if a fault is suspected.

Disconnect the Sensor wires from inside the Jet Junction Box. (Take note of the terminal numbers for correct Re-connection).

Unscrew the Conduit connector from the Jet Junction Box.

Unscrew the Hex Adaptor from the JHPU Tank.

Remove the sensor O-Rings and bonded seals.

Replace the O-Ring and Bonded seals and if necessary the Sensor.

When refitting the Level Sensor, the tip of the bent tube must be pointing into the centre of the JHPU Tank.

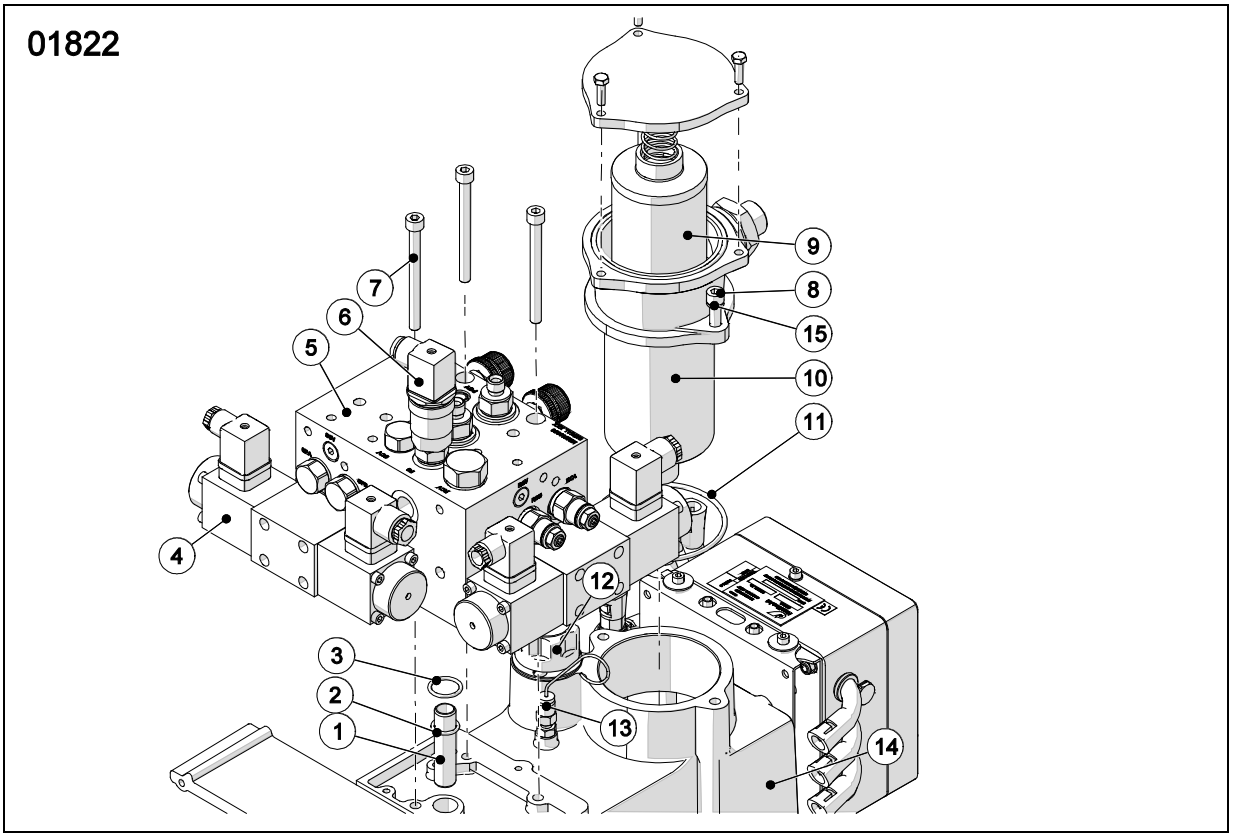


Figure 43: Jet Mounted Hydraulic Power Unit

1	107142	P-Port Tube	9	065050	Filter Element
2	200960	O-Ring	10	065049	Return Line Filter
3	200962	O-Ring	11	Oil Filter O-Ring(Supplied with filter)	
4	064331	Proportional Valve	12	065028	Filler Breather
5	202768	Manifold Block	13	064783	Dipstick
6	065346	Oil Pressure Sensor	14	CTHPU22000	Hydraulic Power Unit
7	030737	M8x90 Cap Screw	15	201394	M8 Spring Washer
8	030850	M8x25 Cap Screw			

Unscrew the cap screws securing the Manifold Block to the tank and carefully lift it away from the JHPU. The P-Port Tube may come away with the manifold block.

Unscrew the cap screws and securing the Filter and withdraw it from the JHPU Tank.

Pump Removal and Inspection

Remove the pulley by unscrewing the 3 x M8 cap screws securing it to the Splined Stub Shaft.

Remove the P-Port tube if it is still protruding from the top of the tank.

Unscrew the 3 x M8 countersunk cap screws and M10 Hex screw securing the Front Mounting Plate. The Mounting Plate complete with the pump can now be removed.

Unscrew the 4 x M6 cap screws securing the P-Port Block to the top of the Pump. Remove the Block.

Unscrew the 4 x M10 Hex screws securing the Pump to the Front Mounting Plate.

Clean and inspect all components.

Check the pump drive spline for wear.

Have the Pump tested by an authorised Casappa dealership and replace if necessary.

Splined Stud Shaft Removal

Remove the retaining circlip from the end of the Splined Stub Shaft.

Press out the Shaft complete with the Roller Bearing Inner Race and Bearing Inner Spacer attached.

Press the Roller Bearing Inner Race and Bearing Inner Spacer from the Stub Shaft.

Press out the Roller Bearing Outer Race, Outer Spacer and Ball Bearing from the Front Mounting Plate.

Press out the Oil Seal from the Front Mounting Plate.

Clean and inspect all components.

Splined Stub Shaft Refitting

Refer: "Splined Stud Shaft Removal" on Page 9-12

Using new Bearings and Oil Seal, reassemble as follows

Warm the Tank Front Mounting Plate to 100° C to aid bearing installation if required.

Press the Oil Seal into the Front Mounting Plate, ensuring that the Spring in the Oil Seal is facing towards the Bearing.

Liberally oil the Stub Shaft, Bearings, Bearing Spacers and Oil Seal.

Press the Roller Bearing Outer Race, Bearing Outer Spacer followed by the Ball Bearing into the Front Mounting Plate behind the Oil Seal.

Press the Roller Bearing Inner Race, followed by the Bearing Inner Spacer onto the Stub Shaft.

Carefully pass the assembled Stub Shaft through the Front Plate, Oil Seal, Roller Bearing and Ball Bearing.

Fit the Circlip to secure the Stub Shaft to the Front Mounting Plate.

Pump Refitting

Refer: "Pump Removal and Inspection" on Page 9-12

Smear new O-Rings with oil and fit to the P-Port Block. Fasten Block to the top of the Pump.

Fit the pump onto the Stub Shaft, turning to help engage the splines.

Fix the Pump to the front plate using 4 x M10 Hex screws and spring washers.

Do not tighten the pump retaining screws completely at this stage.

Temporarily refit the pump and Front plate into the JHPU Tank. Fit the P-Port tube through the JHPU Tank into the P-Port block letting the pump rotate to allow correct alignment. Carefully remove the P-Port tube.

Carefully remove Front Plate and Pump assembly from JHPU Tank and fully tighten pump retaining screws.

If replaced, refit check valve and seals to P-Port block.

Smear a new O-Ring with oil and fit to the Front Plate. Refit front Plate complete with pump to the JHPU Tank ensuring the O-Ring is correctly seated in its groove.

Re-secure Front Plate to JHPU Tank.

Refit the Driven Pulley to the Splined Stub Shaft.

Oil the P-Port Tube and fit through the top of the JHPU Tank and down into the P-Port Block.

Manifold Block and Filter Refitting

Refer: "Manifold Block & Filter Removal" on Page 9-11

Smear a new O-Ring (200962) with oil and insert into the groove on the underside of the Manifold Block.

Smear a new O-Ring (200960) with oil and fit into the P-Port Cavity in the Manifold Block.

Being careful not to displace the O-Ring, place the Manifold Block onto the top of the Tank and the protruding P-Port Tube.

Refit the Manifold Block onto the top of the Tank. Do not over tighten the screws.

Refit the Filter to the top of the Tank. Do not over tighten the screws.

Refit JHPU to the Jet Unit

Refer: "JHPU Removal" on Page 9-10

Refit shims to the JHPU Mounting studs in the Bearing Housing.

Shims must be refitted in the same position and quantity as previously removed.

Refit the JHPU to the mounting studs in the Bearing Housing.

Fit the special round washer (113037) and nut to the top mounting stud and the rectangular washer (107144) and nut to the bottom stud. Hand tighten only at this stage.

Ensure the forward part of the Belt Tensioner is correctly positioned against the side of the Bearing Housing.

Fit the V-Belts onto the Jet Coupling and then onto the JHPU Pulley.

Adjust V-Belt tension.

After the belts have been tensioned, slacken off the upper mounting nut and apply Loctite 222 to the threads of the stud. Tighten to correct torque.

Tighten lower mounting nut to correct torque.

Check V-Belt tension is still correct.

V-Belt alignment is factory set. If the shims are replaced in the correct position when refitting the JHPU, no adjustment should be needed.

However the V-Belt alignment must still be checked after the JHPU is refitted.

If the alignment is outside the specified range, the JHPU Pulley position can be adjusted by fitting or removing Shims between the JHPU Unit and the Bearing Housing.

Ensure the thickness of shims used is the same for both top and bottom mounting.

To check V-Belt alignment:

- Place a straight edge along the front face of the JHPU pulley so that it extends across to the Coupling.
- Measure the distance from the straight edge to the start of the V-groove of the pulley and coupling. The difference in the measurements is the value of the misalignment, which should be less than that specified.

V-Belt Tension

Check and adjust the v-Belt tension Refer: "Checking V-Belt Tension" on Page 8-5.

Refill the JHPU with oil

Refill the JHPU with the correct grade of oil. Refer: "Recommendations for Lubricants and Oils" on Page 10-18

Oil Cooler System

Visually inspect the hydraulic connections and the oil cooler cover plate gasket for leaks and damage.

If hydraulic connectors are removed, fit blanking plugs to prevent the entry of dirt and moisture.

VDO Sender Adjustment

In some installations separate independent Steering and Reverse Indicators may be fitted as backup.

Adjusting VDO Senders

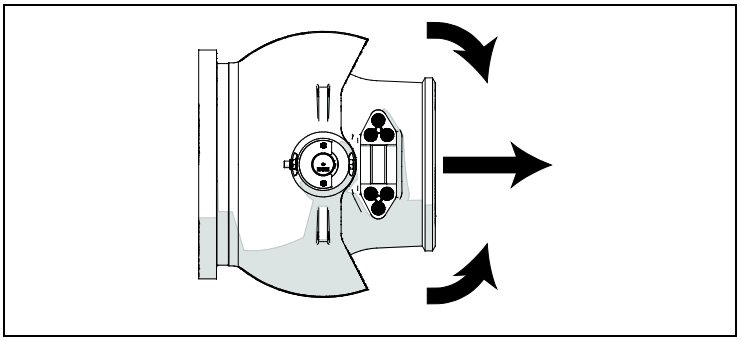
The VDO Senders can be adjusted to give optimal deflection of the Steering or Reverse indicator gauge.

Adjusting the VDO Sender involves moving the steering between full starboard and full port. Make sure that during this process, the steering will not push or pull the VDO sender past its mechanical limits.

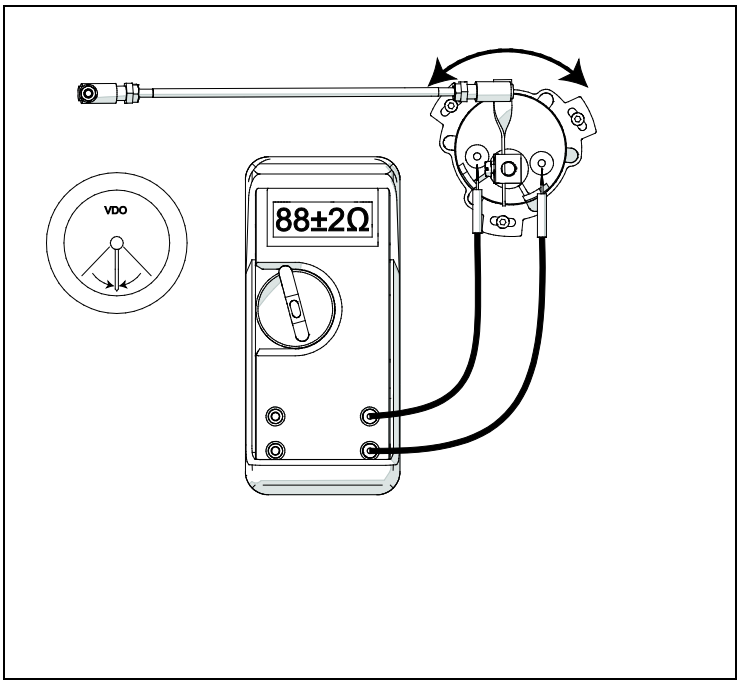
Make sure the Sender mounting screws [A] are positioned centrally in their slots.

Set the Link Rod [X]and sender arm [Y] to the nominal dimensions shown on the relevant assembly drawing.

Dead Ahead Adjustment



Centre the Steering so that the Jet Nozzle is in the Dead Ahead position.



A multimeter may be used to check the dead ahead position if the indicator is not yet fitted.

Disconnect one of the wires from the sender terminal.

Measure the resistance across the Terminals.

The resistance at the dead ahead position should be 88±2Ω

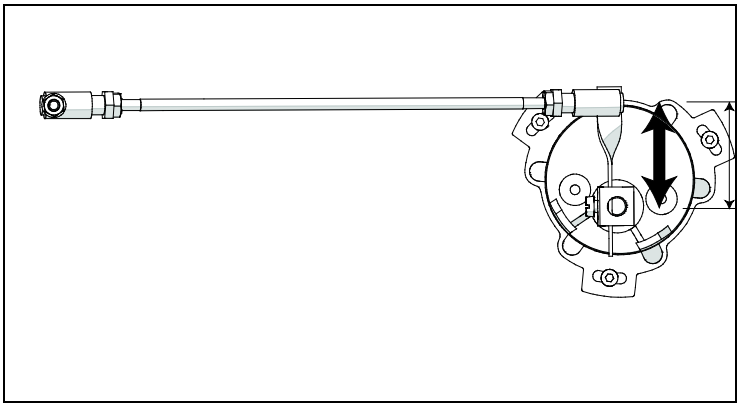
If fitted, check to see if the indicator is showing dead ahead.

To adjust, loosen the screws holding the sender to its bracket.

Rotate the sender as necessary until the resistance is in the range specified or the indicator is pointing dead ahead.

Re-tighten the Sender mounting screws

Span Adjustment



To adjust the range of movement (span) of the indicator Gauge Needle:

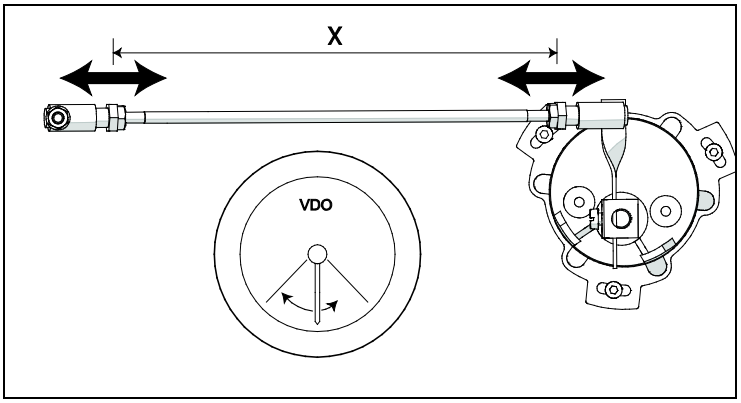
Increasing the sender arm length [Y] decreases the span of the gauge.

Move the Steering Nozzle through its full travel from port to starboard and note the position of the needle.

The needle must have maximum movement while keeping at least a 1mm gap from its mechanical limits.

When the sender is correctly positioned, it is likely to be closer to its anticlockwise (starboard) mechanical limit.

Linearity Adjustment



To adjust needle movement port or starboard:

Although the span and mid-position of the gauge is set using the two previous parameters, the gauge movement may still be uneven, moving more to one side than the other.

Adjust the connecting rod length [X] to change the amount of movement either port or starboard.

Redo the dead ahead adjustment

Making any one of these adjustments will have a secondary effect on the others.

9

10 - Appendix

In This Section

Conversions

Torque

1 pound foot = 1.3558 newton metres
1 newton metre = 0.7375 pounds foot

Distance

1 inch = 2.54 centimetres
1 foot = 0.3048 metre
1 mile = 1.609 kilometres
1 nautical mile = 1.8532 kilometres
1 millimetre = 0.03937 inches
1 metre = 3.2808 feet
1 kilometre = 0.6214 mile
1 kilometre = 0.539 nautical mile

Area

1 inch² = 6.4516 centimetres²
1 foot² = 929.03 centimetres²
1 centimetre² = 0.1550 inch²
1 metre² = 10.76 feet²

Power

1 horsepower = 0.7457 kilowatts
1 horsepower (Metric) = 0.7355 kilowatts
1 kilowatt = 1.341 horsepower
1 kilowatt = 1.3596 metric horsepower

Force

1 kilonewton = 224.86 pounds force
1 pound force = 4.448 newtons

Weight

1 ounce = 28.35 grams
1 pound = 0.4536 kilograms
1 gram = 0.0353 ounce
1 kilogram = 2.205 pounds
1 tonne = 2205 pounds

Temperature

Fahrenheit	Celsius
248	120
212	100
176	80
140	60
104	40
95	35
86	30
77	25
68	20
59	15
50	10
41	5
32	0

Liquid Measure (Imperial)

1 Pint = 0.5506 litre
1 gallon =4.546 litres
1(UK) gallon = 1.201 (US) gallon
1 litre = 0.2199 (UK) gallons
To Convert Fahrenheit to Celsius, subtract 32 then multiply by 5/9
To convert Celsius to Fahrenheit, multiply by 9/5 then add 32.

Liquid Measure (U.S.)

1 pint = 0.473 litre
1 gallon = 3.785 litres

Speed

1 mile per hour = 0.8690 knots
1 kilometre per hour = 0.5396 knots
1 knot = 1.8532 kilometres per hour
1mile per hour = 1.609 kilometres per hour
1 kilometre per hour = 0.621 miles per hour
1 knot = 1.151 miles per hour

Pressure

1 pound/inch² = 0.0689 bar
1 pound/foot² = 4.8824 kilogram/metre²
1 pound/inch² = 6.895 kilopascal
1 Newton/millimetre² = 145.04 pounds/inch²
1 bar = 14.5038 pounds/inch²
1 kilogram/metre² = 0.2048 pounds/foot²
1 kilopascal = 0.145 pound/inch²
1 bar = 100 kilopascal

Loctite Application Guide

85144 Issue F

General Practice

No smoking in the presence of Primer, Activator or Accelerator, as these products are highly flammable. Never mix Primer or Activator and Adhesive directly as liquids. For additional safe handling procedures refer to the product material safety data sheets (MSDS) and technical data sheets (TDS) available from www.Loctite.com

- All parts must be free from oil and or grease. Do not use paint thinners for cleaning. Use solvent or degreaser such as Methylated Spirits, Trichlorethylene or Acetone.
- All painted bores must be fully cured before the application of Loctite.
- Fixing and full cure times for all Loctite will be increased at reduced temperatures.
- To prevent the product from clogging in the nozzle, do not allow the tip to touch metal surfaces during application.
- In general, nuts that secure anodes use Loctite 243 and a spring washer. Anodes in internal water passages use nyloc nuts, external anodes use plain nuts.

Primers, Activators and Accelerators

Primers are used when the surfaces to be threadlocked are not active enough to cause curing, or when the cure is required to be accelerated.

- Primers, Activators or Accelerators are not required on ‘active surfaces’, such as Bronze, Brass and Mild steel.
- For ‘Inactive Surfaces’ (including Stainless Steel or Aluminium) Primers, Activators or Accelerators are optional for threadlocking and are required for retaining.
- Primers, Activators or Accelerators are not to be applied to any painted surface.
- Allow sufficient time for Primers, Activators or Accelerators, where applied, to dry.

Equivalents

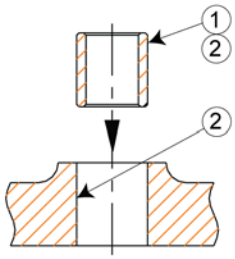
Loctite Grade		Equivalent
222	Purple	Low Strength Threadlocker: ▪ Loctite 221 (Compatible Primer is 7471) ▪ Loctite 225 (Compatible Primer is 7471)
243	Blue	Medium Strength Threadlocker: ▪ Loctite 242 (Compatible Primer is 7471) ▪ Loctite 245 (Compatible Primer is 7471) ▪ Loctite 248 (Compatible Primer is 7471)
263	Red	High Strength Threadlocker: ▪ Loctite 262 (Compatible Primer is 7471 or 7649) ▪ Loctite 268 (Compatible Primer is 7471 or 7649) ▪ Loctite 276 (No Primer Required) ▪ Loctite 277 if necessary (Compatible Primer is 7649)
680	Green	High Strength Retainer: ▪ Loctite 638 (Compatible Primer is 7471)
325	Amber	Structural Adhesive: ▪ Loctite 317 (Compatible Primer is 736)
542	Brown	Hydraulic Thread Sealant: ▪ Loctite 569 (Compatible Primer is 7471 or 7649) ▪ Loctite 561 (Compatible Primer is 7471 or 7649) ▪ Loctite 577 (Compatible Primer is 7471 or 7649)

Additional Notes for Equivalents

- Primer 7471 and Primer 7649 can be interchanged if necessary, however performance may be reduced
- Loctite 248, 268, 668 and 561 are in stick form.

Unpainted Bores, Stainless Bushes

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
680	*GREEN*	Type	Drying Time		Partial	Full
		n/a	n/a		30 Min	4-6 Hrs



Bushes, Sleeves, Composite Bush Assemblies. (extra high strength retaining) Primer will be used in all retaining applications.

1 - Apply Primer to whole surface of Bore and allow to dry before fitting.

2 - Apply Loctite to whole surface of bore and front of bush before fitting.

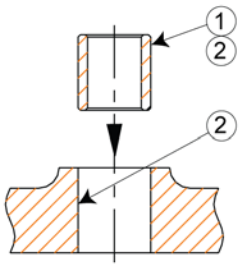
- There are to be no dry areas between the Bush and the Bore.

Rotate Bush when fitting to distribute the Loctite evenly

For Press Fitted Bushes, coat the entire Bush and Bore before pressing in the Bush.

Unpainted Bores, LG2 Bushes

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
680	*GREEN*	Type	Drying Time		Partial	Full
		n/a	n/a		30 Min	4-6 Hrs



Bushes, Sleeves, Composite Bush Assemblies. (extra high strength retaining) Primer will be used in all retaining applications.

Do not apply primer to LG2 Bushes

1 - Apply Primer to whole surface of Bore and allow to dry before fitting.

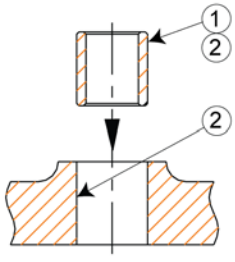
2 - Apply Loctite to whole surface of Bore and front of Bush before fitting.

- There are to be no dry areas between the Bush and the Bore.
- Rotate Bush when fitting to distribute the Loctite evenly

For Press Fitted Bushes, coat the entire Bush and Bore before pressing in the Bush.

Painted Intercure Bores, Stainless Steel Bushes

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed with Primer Activator, Accelerator		
325	*AMBER*	Type	Drying Time		Partial	Full
		Activator 7075	1-3 Min		5 Min	24 Hrs



Bushes, Sleeves, Composite Bush Assemblies. (high strength adhesive) Activator will be used in all retaining applications.

325 Loctite will not cure without the Activator. Do not apply Activator to painted Bores.

1 - Apply Activator to outside of Bush and allow to dry.

2 - Apply Loctite to whole surface of Bore and outside of Bush before fitting Bush.

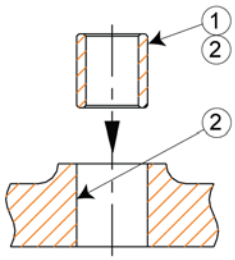
- There are to be no dry areas between Bush and Bore.

Rotate Bush when fitting to distribute the Loctite evenly

10

Painted Gloss Bores, Stainless Steel Bushes

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
680	*GREEN*	Type	Drying Time		Partial	Full
		n/a	n/a		30 Min	4-6 Hrs



Bushes, Sleeves, Composite Bush Assemblies. (Extra high strength retaining)

Primer is used in all retaining applications.

Do not apply Primer to painted Bore.

1 - Apply Primer to outside of outside of Bush and allow to dry.

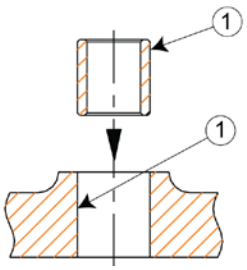
2 - Apply Loctite to whole surface of Bore and outside of Bush before fitting Bush.

- There are to be no dry areas between Bush and Bore.

Rotate Bush when fitting to distribute the Loctite evenly

Painted Gloss Bores, LG2 Bushes

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
680	*GREEN*	Type	Drying Time		Partial	Full
		n/a	n/a		30 Min	4-6 Hrs



Bushes, Sleeves, Composite Bush Assemblies. (Extra high strength retaining)

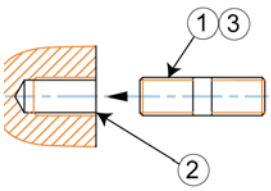
1 - Apply Loctite to whole surface of Bore and outside of Bush before fitting Bush.

- There are to be no dry areas between Bush and Bore.

Rotate Bush when fitting to distribute the Loctite evenly

Studs M8 and Larger

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed		
263	*RED*	Type	Drying Time		Partial	Full
		Primer 7649	30-70 Sec	With Primer	10 Min	2 Hrs
		(Optional)	n/a	Without Primer	20 Min	6 Hrs



Studs (high strength locking)

Primer is used to improve cure reliability, and reduce cure time.

1 - Apply optional Primer to the thread of the Stud and allow to dry.

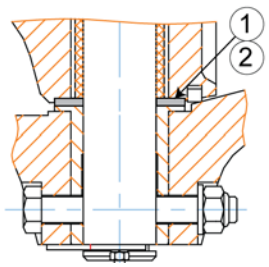
2 - Apply several drops of Thread Locker down the sides of female thread.

3 - Apply Loctite to the thread engagement area of the Stud in sufficient quantity to fill all engaged threads.

Assemble the Stud to specifications.

D-Glide Thrust Washers

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed with Primer Activator, Accelerator		
325	*AMBER*	Type	Drying Time		Partial	Full
		Activator 7075	1-3 Min		5 Min	24 Hrs



D-Glide Thrust Washer retention (high strength adhesive)

Activator will be used in all retaining applications.

325 Loctite will not cure without the Activator.

1 - Apply Activator to one side of Thrust Washer and allow to dry.

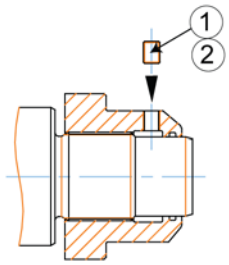
2 - Apply Loctite evenly to Housing Recess.

- Press Thrust Washer into Recess, Activator side to Adhesive.
- Remove any excess Loctite from the Bush Bore.

Hold the Washer in place, for approx. 15 minutes, until the bond is firm.

Machine Set Screws, Set Screws, Grub Screws

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed		
243	*BLUE*	Type	Drying Time		Partial	Full
		Primer 7471	30-70 Sec	With Primer	10 Min	2 Hrs
		(Optional)	n/a	Without Primer	20 Min	6 Hrs
222	*PURPLE*	Primer 7471	30-70 Sec	With Primer	10 Min	2 Hrs
		(Optional)	n/a	Without Primer	20 Min	6 Hrs



Machine Screws, Set Screws, Grub Screws (low strength thread locking).

Primer is used to shorten the cure time when the temperature is below 15°.

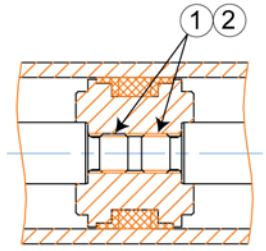
1 - Apply optional Primer to the thread of the Screw and allow to dry. Screws fitted into Bronze do not require Primer.

2 - Apply Loctite to the thread engagement area of the Screw in sufficient quantity to fill all engaged threads.

3 Fit the Screw to the specified torque.

Cylinder Shafts, Compensator Shafts

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed		
263	*RED*	Type	Drying Time		Partial	Full
		Primer 7649	30-70 Sec	With Primer	10 Min	2 Hrs
		(Optional)	n/a	Without Primer	20 Min	6 Hrs



Cylinder Shafts, Compensator Shafts (hydraulic, pneumatic thread sealant).

Primer is used to shorten the cure time when the temperature is below 15°.

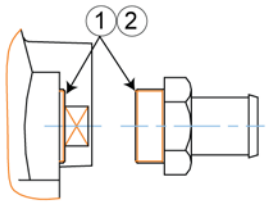
1 - Apply optional Primer to the threads of the Shafts and allow to dry.

2 - Apply Loctite to the female threads in the Piston and to the threads on the Shafts in sufficient quantity to fill all the threads.

Assemble the Shafts and Piston as per the drawing specifications.

Water Offtake Bungs and Hose Tails

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed		
567	*White*	Type	Drying Time		Partial	Full
		Accelerator 7649 (Optional)	30-70 Sec	With Primer	2 Hrs	6 Hrs
				Without Primer	12 Hrs	24 Hrs



Water Offtake Bungs & Hose Tails (thread sealant)

Accelerator is used where cure speed is unacceptably long.

1 - Apply optional Accelerator to thread of Plug or Hose Tail and allow to dry.

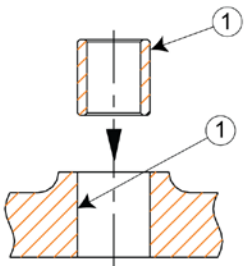
2 - Do not apply Accelerator to Brass Hose Tails.

3 - Apply Loctite to thread engagement area of the Plug or Hose Tail leaving the first thread Loctite free.

Screw Plug or Hose Tail into Tailpipe until Plug or Hose Tail bottoms, and tighten firmly.

Unpainted Bores, D-Glide Bushes

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed with Primer Activator, Accelerator		
325	*AMBER*	Type	Drying Time		Partial	Full
		Activator 7075	1-3 Min		5 Min	24 Hrs



D-Glide Bush retention (high strength adhesive).

Activator will be used in all retaining applications.

325 Loctite will not cure without the Activator.

1 - Apply Activator to outside of Bush and allow to dry.

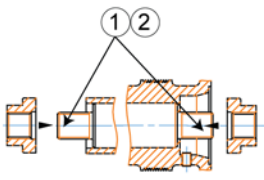
2 - Apply adhesive to whole surface of Bore.

- There are to be no dry areas between Bush and Bore.

Press Bush into Bore within 15 minutes.

Mainshaft Nuts Without Locking Devices

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed		
243	*BLUE*	Type	Drying Time		Partial	Full
		Primer 7471 (Optional)	30-70 Sec	With Primer	10 Min	2 Hrs
			n/a	Without Primer	20 Min	6 Hrs



Mainshaft Nuts (medium strength thread locking)

Primer is used to shorten the cure time when the temperature is below 15°.

1 - Apply optional Primer to the threads on the Mainshaft and allow to dry.

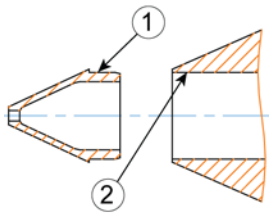
2 - Apply Loctite to the thread engagement areas of the Mainshaft in sufficient quantity to fill all engaged threads.

Assemble Nuts to `Jet Specific' torque specifications.

10

Tailpipe Fairings Without Locking Devices

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
680	*GREEN*	Type	Drying Time		Partial	Full
		n/a	n/a		30 Min	4-6 Hrs



Tailpipe Fairings without Locking Devices (extra high strength retaining).

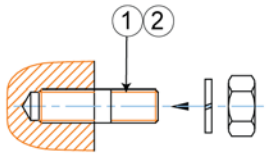
1 - Apply Primer to Spigot of Fairing and allow to dry.

2 - Apply Loctite to Spigot Bore of Tailpipe.

Fit using normal methods.

Nuts on Studs and Bolts (Where Specified)

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed		
243	*BLUE*	Type	Drying Time		Partial	Full
		Primer 7471	30-70 Sec	With Primer	10 Min	2 Hrs
		(Optional)	n/a	Without Primer	20 Min	6 Hrs
222	*PURPLE*	Primer 7471	30-70 Sec	With Primer	10 Min	2 Hrs
		(Optional)	n/a	Without Primer	20 Min	6 Hrs



Nuts (low strength thread locking).

Primer is used to shorten the cure time when the temperature is below 15°.

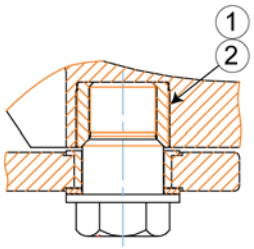
1 - Apply optional Primer to the thread of the Stud or bolt and allow to dry.

2 - Apply Loctite to the thread engagement area of the Stud or Bolt in sufficient quantity to fill all engaged threads.

Tighten Nuts to specified torque.

Tailpipe Inserts (Where Fitted)

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed		
263	*RED*	Type	Drying Time		Partial	Full
		Primer 7649	30-70 Sec	With Primer	10 Min	2 Hrs
		(Optional)	n/a	Without Primer	20 Min	6 Hrs



Tailpipe Inserts (high strength thread locking).

Primer is used in all retaining applications.

1 - Apply Primer to the thread of the Insert and allow to dry.

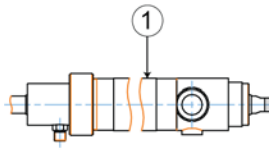
2 - Apply Loctite to the female threads in the Tailpipe and the threads of the Insert in sufficient quantity to fill all the engaged threads.

- There are to be no dry areas between Insert and Tailpipe threads.

Screw Insert into the Tailpipe until it bottoms. Tighten firmly.

Steel Cylinders and AB2 Frontheads

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
542	BROWN	Type	Drying Time		Partial	Full
		n/a	n/a		45 Min	24 Hrs



Steel Cylinders and AB2 Frontheads (Med strength hydraulic thread sealant)

Leave the first thread free of sealant.

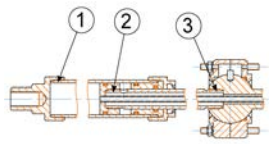
Force the sealant into the threads to thoroughly fill all threads.

1 - Apply Loctite to the leading threads of the cylinder (Fronthead end only).

Assemble the Fronthead to the Cylinder and tighten firmly.

Stainless Steel Cylinders and Backheads

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
542	BROWN	Type	Drying Time		Partial	Full
		n/a	n/a		45 Min	24 Hrs



Stainless Steel Cylinders & Backheads (Med strength hydraulic thread sealant).

Leave the first thread free of sealant.

Force the sealant into the threads to thoroughly fill all threads.

1 - Apply Loctite to the leading threads of the Cylinder (Backhead end).

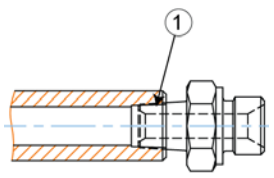
2 - Apply Loctite to the Shaft threads (Piston end).

3 - Apply Loctite to the Shaft thread (Connector end).

Fit the Shaft into the Piston and Connector and tighten the Backhead to the torque specified on the assembly drawing.

Tapered Male Nipples into Female Holes

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
542	BROWN	Type	Drying Time		Partial	Full
		n/a	n/a		45 Min	24 Hrs



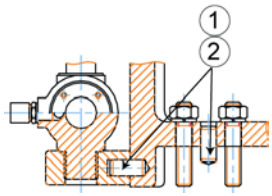
Tapered Male Nipples in Female Holes (Medium Strength Hydraulic Thread Sealant).

1 - Apply Loctite to the thread engagement area of the Nipple in sufficient quantity to fill all engaged threads.

Fit the Nipple and tighten to the specified torque.

Dowel Retention

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
680	*GREEN*	Type	Drying Time		Partial	Full
		n/a	n/a		30 Min	4-6 Hrs



Dowel retention (extra high strength retaining).

Dowels are to be retained at one end only.

1 - Apply Primer to one end of Dowel and allow to dry.

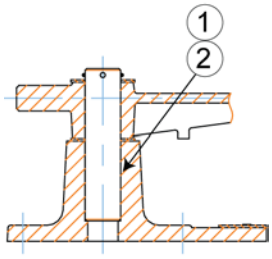
2 - Apply Loctite to Dowel hole in either Casting or Mounting Plate, not both.

- Fit the end of the Dowel with the Primer into the hole that has the Loctite.

Remove excess Loctite from the Dowel, before fitting the Mounting Plate over the Dowel.

Steering Crank Shaft and Mounting Block

Loctite	Colour	Primer, Activator, Accelerator		Loctite Cure Speed without Primer Activator, Accelerator		
680	*GREEN*	Type	Drying Time		Partial	Full
		n/a	n/a		30 Min	4-6 Hrs



Steering Crank Shaft to Mounting Block (Extra high strength retaining).

1 - Apply Primer to bottom half of Shaft and allow to dry.

2 - Apply Loctite to the Bore of the Mounting Block and the bottom half of the Shaft.

Heat the Mounting Block if required.

Press the Shaft into the Mounting Block.

Remove excess Loctite from the top half of the Shaft

Threaded Fastener Tightening Torques

85113 Issue T

Make sure all threads are clean

Lubricate all Stainless Steel threads unless otherwise specified. (Loctite® specified)

Where Loctite® is specified Refer: "Loctite Application Guide" on Page 10-3.

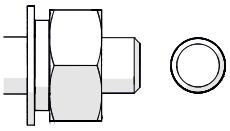
For specific instructions on tightening torques for Impeller Nuts, Coupling Nuts, and Bearing Lock Nuts refer to the relevant Jet Assembly Drawing.

Torques specified in assembly drawings take precedence over this drawing. Use this drawing when the assembly drawing does not specify torque for the fastener

Nut Tightening Torque

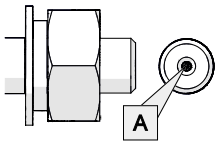
Nuts on 316 Stainless Steel Studs (Non Magnetic)

Size	Torque
M6	5 N·m (3.6 lbf·ft)
M8	12 N·m (9 lbf·ft)
M10	24 N·m (18 lbf·ft)
M12	45 N·m (33 lbf·ft)
M16	75 N·m (55 lbf·ft)
M20	120 N·m (90 lbf·ft)



Nuts on 2205 Stainless Steel Studs (Magnetic)

Size	Torque	
	With Grease	With Antiseize
M12	60 N·m (44 lbf·ft)	45 N·m (33 lbf·ft)
M16	150 N·m (110 lbf·ft)	110 N·m (80 lbf·ft)
M20	270 N·m (200 lbf·ft)	210 N·m (155 lbf·ft)
M24	470 N·m (345 lbf·ft)	350 N·m (260 lbf·ft)
M30	900 N·m (660 lbf·ft)	650 N·m (480 lbf·ft)



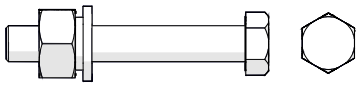
A - Centre Drill

Nuts on 316 Stainless Steel Cotter Pins

Size	Torque
M6	5 N·m (3.6 lbf·ft)
M8	12 N·m (9 lbf·ft)
M10	24 N·m (18 lbf·ft)
M12	45 N·m (33 lbf·ft)

Nuts on Bolts and Screws

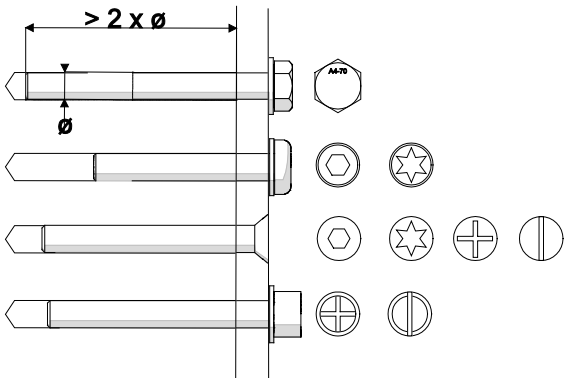
Size	Torque
Metric	
M3	0.8 N·m (0.6 lbf·ft)
M4	2 N·m (1.5 lbf·ft)
M5	4 Nm (3 lbf·ft)
M6	7 N·m (5 lbf·ft)
M8	16 N·m (12 lbf·ft)
M10	33 N·m (24 lbf·ft)
M12	60 N·m (44 lbf·ft)
M16	140 N·m (103 lbf·ft)
M20	260 N·m (190 lbf·ft)
M24	410 N·m (300 lbf·ft)
Imperial	
1/4" UNC	7.5 N·m (5.5 lbf·ft)
5/16" UNC	15.3 N·m (11.3 lbf·ft)
3/8" UNC	27 N·m (20 lbf·ft)
1/2" UNC	65 N·m (48 lbf·ft)
5/8" UNC	130 N·m (96 lbf·ft)
3/4" UNC	230 N·m (170 lbf·ft)



Screw Tightening Torques

Bolts and Screws in all Metals

Size	Torque
Metric	
M2	0.2 N·m (0.15 lbf·ft)
M2.5	0.35 N·m (0.25 lbf·ft)
M3	0.6 N·m (0.4 lbf·ft)
M4	5 N·m (3.6 lbf·ft)
M5	3 N·m (2.2 lbf·ft)
M6	5 N·m (3.6 lbf·ft)
M8	12 N·m (9 lbf·ft)
M10	24 N·m (18 lbf·ft)
M12	45 N·m (33 lbf·ft)
M16	95 N·m (70 lbf·ft)
M20	180 N·m (133 lbf·ft)
Imperial	
1/4" UNC	5 N·m (3.6 lbf·ft)
5/16" UNC	11 N·m (8 lbf·ft)
3/8" UNC	19 N·m (14 lbf·ft)
1/2" UNC	48 N·m (35 lbf·ft)
5/8" UNC	89 N·m (66 lbf·ft)
3/4" UNC	160 N·m (118 lbf·ft)

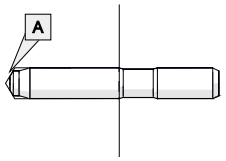


The minimum thread length required in aluminium castings is twice the Screw or Bolt diameter

Stud Installation

Rolled Formed Studs with Nose

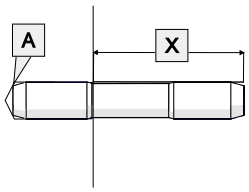
Size	Torque
M12	18 N·m (13 lbf·ft)
M16	30 N·m (22 lbf·ft)
M20	48 N·m (35 lbf·ft)
M24	180 N·m (133 lbf·ft)
M30	370 N·m (270 lbf·ft)
	316 or 2205 Stainless Steel A - Nose on Stud Bottomed in Hole



Rolled Formed Studs without Nose

Thread Stud into casting until thread bottoms. Confirm the stud protrusion is equal to stud length minus thread length as per stud description

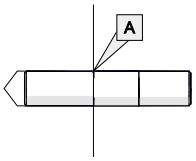
A - No Nose, Stud Bottomed on thread
X = Stud Length minus thread length



Cut Thread Studs

Thread Stud into casting until thread disappears.
Do Not thread Past This Point

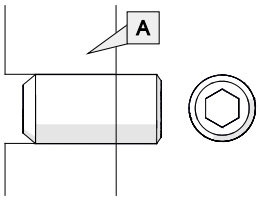
A - Stop threading when thread disappears.



Set Screws

Set Screw Tightening Torques (non aluminium)

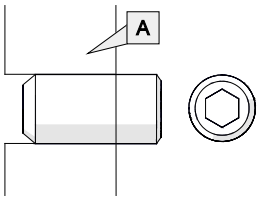
Size	Torque
M3	0.6 N·m (0.4 lbf·ft)
M4	1.5 N·m (1.1 lbf·ft)
M5	3 N·m (2.2 lbf·ft)
M6	5 N·m (3.6 lbf·ft)
M8	12 N·m (9 lbf·ft)
M10	24 N·m (18 lbf·ft)
M12	45 N·m (33 lbf·ft)
A	Steel Stainless Steel, Bronze Water Seal Rotary



10

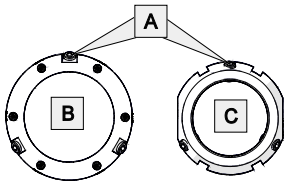
Set Screw Tightening Torques (aluminium)

Size	Torque
M3	0.4 N·m (0.3 lbf·ft)
M4	1 N·m (0.7 lbf·ft)
M5	2 N·m (1.5 lbf·ft)
M6	3.3 N·m (2.5 lbf·ft)
M8	8 N·m (6 lbf·ft)
M10	16 N·m (12 lbf·ft)
M12	30 N·m (22 lbf·ft)
	A - Aluminium



Tightening torques for KMT Nuts

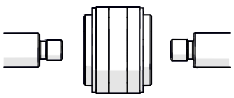
Size	Torque
M6	8 N·m (6 lbf·ft)
M8	18 N·m (13 lbf·ft)
M10	35 N·m (26 lbf·ft)
	A - Locking Screws B - KMTA Nut C - KMT Nut



Hydraulic Cylinder Piston

Stainless Threads on Mild Steel

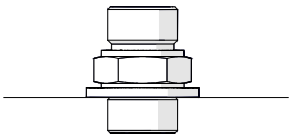
Size	Torque
M16x2	75 N·m (55 lbf·ft)
M24x3	250 N·m (184 lbf·ft)



Hydraulic Fittings

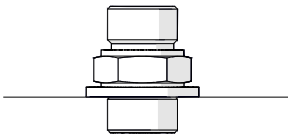
BSPP Fittings in Jet Castings

Size	Torque
1/8	4 Nm (3 lbf·ft)
1/4	10 N·m (7 lbf·ft)
3/8	20 N·m (15 lbf·ft)
1/2	40 N·m (29.5 lbf·ft)
3/4	63 N·m (46 lbf·ft)
1	105 N·m (77 lbf·ft)
1-1/4	142 N·m (105 lbf·ft)
1-1/2	320 N·m (240 lbf·ft)
2	500 N·m (370 lbf·ft)



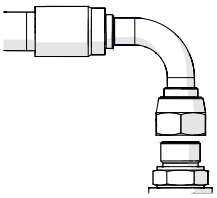
BSPP Fittings other than Jet Castings

Size	Torque
1/8	9 N·m (7 lbf·ft)
1/4	35 N·m (26 lbf·ft)
3/8	45 N·m (33 lbf·ft)
1/2	65 N·m (48 lbf·ft)
3/4	130 N·m (96 lbf·ft)
1	160 N·m (118 lbf·ft)
1-1/4	240 N·m (177 lbf·ft)
1-1/2	320 N·m (240 lbf·ft)
2	500 N·m (370 lbf·ft)



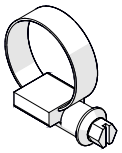
Hoses

Size	Torque
1/8	7 N·m (5 lbf·ft)
1/4	20 N·m (15 lbf·ft)
3/8	35 N·m (26 lbf·ft)
1/2	60 N·m (44 lbf·ft)
3/4	115 N·m (85 lbf·ft)
1	140 N·m (103 lbf·ft)
1-1/4	210 N·m (155 lbf·ft)
1-1/2	290 N·m (214 lbf·ft)
2	400 N·m (295 lbf·ft)



Hose Clips

Part #	Size	Torque
201056	12-20	2.3 N·m (1.6 lbf·ft)
201057	14-32	4 Nm (3 lbf·ft)
201058	30-45	5 N·m (3.6 lbf·ft)
201059	40-60	5 N·m (3.6 lbf·ft)
205780	50-70	5 N·m (3.6 lbf·ft)
201060	60-80	5 N·m (3.6 lbf·ft)
206094	80-100	5 N·m (3.6 lbf·ft)
064924	51-55	15 N·m (11 lbf·ft)
209872	59-63	15 N·m (11 lbf·ft)



Thread Lubricants

Thread Type	Lubricant
316 Stainless Studs	Multipurpose Marine Grade Grease
2205 Stainless Studs	Multipurpose Marine Grade Grease or Marine Grade Anti-seize. Anti-seize will reduce the risk of thread galling so is recommended on M20 and larger
Other metric fasteners	Multipurpose Marine Grade Grease
1/4" UNC - 1/8" UNC	Multipurpose Marine Grade Grease
3/4" UNC	Marine Grade Anti-seize
Bronze Impeller or Coupling Nuts	Multipurpose Marine Grade lithium Based Grease
Hydraulic Fittings	General Purpose Grease or Hydraulic Oil e.g. Accrolube®

Examples

	Multipurpose Marine Grade lithium Based Grease	Shell: Shell Alvania RL2 Mobil: Mobilux 2, Mobilux EP 2 Castrol: Molub - Alloy 6040 BP: Engergrease MP-MG 2
	Marine Grade Anti-seize	Loctite Marine Grade Anti-seize

Anti-Seize Compounds

Do not use anti-seize compounds which are based on graphite, nickel or copper flakes - these will cause corrosion.

Anti-seize compounds, usually containing zinc flakes, are available for aluminium.

When using Anti-seize on nuts fitted to 2205 studs, only use Loctite® Marine Grade Anti Seize to achieve the correct stud preload.

10

Recommendations for Lubricants and Oils

Hydraulic Fluids

085018 Issue U

Seastar Manual & Powered Hydraulic Steering

Fluids

Fluids meeting MIL H5606C Specifications	
Do Not Use:	Brake Fluid
	Heavier viscosity fluids

Examples

Seastar:	HA5430 (1qt), HA5440 (1US gal)
Shell:	Shell Aero Fluid 4
Shell:	Shell Aero Fluid 41
Esso:	Univis N15 or J13
Texaco:	HO15
Mobil:	Mobil Aero HFA
Chevron:	Aviation Fluid A

Used on Jet models

Manual Steering	HJ213	HJ214	HJ274	HJ292	HJ322
Power Steering	HJ403	HM461	HM521	HM571	

Wagner Manual Hydraulic Steering

Fluid

ISO VG32 Hydraulic Oil Brake Fluid	
Do Not Use:	Automatic transmission fluid
	Heavier viscosity fluids

Examples

Shell:	Tellus 32
Esso:	Nuto H32
Texaco:	Rando HD32 or Rando HD AZ
Chevron:	AW 32
Exxon:	Nuto H32
Gulf:	Harmony AW32
Mobil:	DTE Excel 32

Used on Jet models

HJ364

Hynautic Remote Control Systems

Fluid

50/50 mixture by volume of Distilled Water and Ethylene-Glycol (anti-freeze). note: Ethylene-Glycol should be as pure as possible (no additives).	
Do Not Use	Brake fluid
	Hydraulic oils

Examples

Hynautic	MCO-03 Hynautic

Used on Jet models

HJ364	HJ403	HM422	HM461	HM521	HM571

Saginaw JHPU

Fluid

Fluids meeting GM Spec. No. 9985010	
Do Not Use:	Brake Fluid
	Heavier viscosity fluids

Examples

Shell:	Donax TM	Auto Transmission Oil.
	Dexron 111	Auto Transmission Oil
Mobil:	ATF	Auto Transmission Oil
Castrol:	TQ Dexron 111	Auto Transmission Oil
Esso:	PSF #91423	Power Steering Fluid
Texaco:	TL-11872	Power Steering Fluid
	TL-15216	Power Steering Fluid

Used on jet models

Jet Model	HJ213	HJ241	HJ274	HJ292	HJ322
Total Oil Volume (ltrs)					
HSRX/HSRC	1.0	1.0	1.2	1.2	1.7
blue ARROW	N/A	N/A	N/A	1.8	2.3

The Saginaw JHPU is shipped filled with oil.

Hamilton Jet JHPU

Fluid

Use Mineral Based Hydraulic Fluid conforming to ISO 11158, DIN 51524 Standards. The Hydraulic Fluid should be selected so that within the operating temperature range, the operating viscosity is within the viscosity range of 16-36 cSt.	
Do Not Use:	Brake Fluid

Examples

Shell:	Tellus 46
Castrol:	Hyspin AWX Multigrade
Mobil:	DTE 25
B.P.:	HLP HM46

Used on jet models

Jet Model	HJ 364	HJ 403	HM 422	HM 461	HM 521	HM 571	HM 651	HM 721	HM 811	HT 810	HT 900	HT 1000
Total Oil Volume (Ltrs)	5.25	7.5	7.5	7.5	7.5	7.5	21	21	21	21	60	80

Unit shipped with no oil in the JHPU, but oil in the Cooler and Control System. JHPU Oil Volume 4 Litres

Bearing Housing Lubrication

Grease Lubricated Bearing Housings

Grease Type

Marine Extreme Pressure Grease

Examples

Shell:	Shell Alvania RL2
Mobil:	Mobilux 2, Mobilux EP 2
Castrol:	Castrol LMX
BP:	Engergrease MM-EP 2

Used on Jet models

HJ212	HJ213	HJ241	HJ274	HJ292	HJ322

Oil Lubricated Bearing Housings

Oil Type

Mineral Based Hydraulic Oil to ISO 11158, DIN 51524 Straight Mineral Oils without EP additives are generally favoured for rolling bearing lubrication. Oils having a high viscosity index of at least 95 are recommended

Examples

Shell:	Tellus 46
Castrol:	Hyspin AWX multigrade
Mobil:	DTE25
BP:	HLP HM46

Used on Jet Models	HJ 364	HJ 403	HM 422	HM 461	HM 521	HM 571	HM 651	HM 721	HM 811	HT 810	HT 900	HT 1000
Oil Cooler Volume (Ltrs)	n/a	n/a	n/a	n/a	n/a	n/a	2.6	5.0	5.0	5.0	6.0	1
Bearing Housing Oil Volume (ltrs)	1.1	3.6	3.6	3.6	3.7	3.7	6.2	7.0	9.3	9.3	14	31.2

Jet Unit oil levels will vary depending on deadrise of hull.
Oil volumes shown are for centrally mounted units with no deadrise. Oil levels must be within the marks shown on the Dipstick.

Joint Lubrication

Impeller and Coupling Taper Joints

Grease

- Multi purpose Lithium Based Grease or Calcium Sulphate Based Grease

Example

- Shell Alvania RL2 or equivalent. Apply a thin film of lubricant to the Shaft Taper.

Steel to Steel Joints

Grease

- Multi purpose Lithium Based Grease or Calcium Sulphate Based Grease

Example

- Shell Alvania RL2 or equivalent. Apply a thin film of lubricant to the Shaft .

O-Rings (Nitrile Rubber Only)

Grease

- Multi purpose Lithium Based Grease or Calcium Sulphate Based Grease

Example

- Shell Alvania RL2 or equivalent. Apply a thin film of lubricant to the O-Ring.
  Do Not grease Barrier Cord O-Rings.

Rotary Water Seal Fitting

Lubricant

- Lubricant Supplied with Water Seal (P80 Liquid Lubricant) or Soapy water

Do Not Use:

- Grease or Oils
  Apply a thin film of lubricant to the Mainshaft before fitting the Water Seal
  Do Not lubricate the Seal Faces.

Module Parameter Summary

The following tables contain details of parameters associated with each module.

These parameters are subject to change and are presented here for illustration and explanation of the parameter functions.

(A) - Automatic parameter, normally set by the system during module set-up **ALL**.

(F) - Factory parameter, not available via the Jet **SetUP** menu.

Control Panel Module Setup Parameters

No	Parameter	Range	Default	Unit	Description
1	Helm Type	Hlm/Hhr	Hlm		Helm Type = Hand Held Remote OR a Helm Unit. The control panel being configured displays HH. This parameter lets you tell the panel what type of helm is connected to it. This option is not available for centre and inner jet CPM's as their helm signals are derived from the outer jet panels (where the helm module is attached). This option is not available for Booster Jet CPM's as they have no steering capability.
2	Helm1 Curve	0 - 6	0		0=Linear Helm Response, 6=Highly De-Sensitised Central Helm Response. The control panel being configured displays HC. The helm curve provides a way to adjust the sensitivity of the helm. A value of 0 means the sensitivity is the same from full to port, through to full to starboard. A value of 6 means the helm is very sensitive close to full to port and full to starboard, but not very sensitive near mid helm. This option is not available on Booster Jets.
3	No. Of Levers	0 - 2	1		0 = Shared, 1 = SLC, 2 = Twin Lever. The control panel being configured displays nL. This parameter sets the Jet for Shared Control (0 lever), SLC Control (1 lever) or Twin Lever Control (2 lever) of the Reverse Duct and Throttle. Shared Control is normally used for centre Jets where the control lever signals are derived from the outer Jet panels (where the control lever modules are attached).
4	Ctrl2Type	None Strg DCM D+St HCM	None		Secondary Control Type. Options: ▪ None = No secondary control at this station ▪ Strg = Secondary Helm only at this station ▪ DCM = Docking Controller Module (DCM) only at this station ▪ D+St = DCM and Secondary Helm only at this station ▪ HCM = 3 Axis manual Controller Module
5	Helm2 Curve	0-6	0		Secondary Helm Responce. As Helm 1 Curve
6	CentreJetBias	0-8	2		Jets averaging of Shared Levers for Centre Jets. '0' = Averages outer Jet levers. '8' = Follows reverse most outer Jet lever. The control panel being configured displays Cb This parameter sets how the centre Jet determines it's Reverse Duct demand from the outer Jet lever positions. A value of '0' means the centre Jet averages the outer Jet lever positions. A value of 8 means that the centre Jet follows the reverse most lever of the outer Jet levers. This parameter is only set for Jets sharing outer levers.

No	Parameter	Range	Default	Unit	Description
7	Port Helm	0x08 - 0x72	0x10		Full Port - Helm Signal. This parameter will not be updated if the new value is outside pre-set limits. The control panel being configured displays HP and flashes the port side of the steering indicator. This parameter sets the full to port position of the helm wheel attached to the control panel. This option is not available for centre and inner Jet CPM's as their helm signals are derived from the outer Jet panels (where the helm module is attached).
8	Stbd Helm	0x98 - 0xf8	0xf0		Full Starboard - Helm Signal. The control panel being configured displays HS and flashes the starboard side of the steering indicator. This parameter sets the full to starboard position of the helm wheel attached to the control panel. This option is not available for centre and inner Jet CPM's as their helm signals are derived from the outer Jet panels (where the helm module is attached).
9	Mid Helm	0x50 - 0xb0	0x80		Mid Position - Helm Signal. Status display indicates H-.
10	Rev Fwd	0x980-0xf80	0xf00		Full Ahead - Reverse Lever / SLC Signal. The control panel being configured displays 'r~' and flashes the forward section of the Reverse Duct indicator. This parameter sets the full ahead position of the SLC or reverse control lever attached to the control panel. This option is not available for centre and inner Jet CPM's with shared lever control as their control lever signals are derived from the outer Jet panels (where the control lever module is attached).
11	Rev Back	0x80-0x680	0x100		Full Astern - Reverse Lever / SLC Signal. The control panel being configured displays r_ and flashes the lower section of the Reverse Duct indicator. This parameter sets the full astern position of the SLC or reverse control lever attached to the control panel. This option is not available for centre and inner Jet CPM's with shared lever control as their control lever signals are derived from the outer Jet panels (where the control lever module is attached).
12	Rev Mid	0x600-0xb00	0x800		Zero Speed - Reverse Lever / SLC Signal. The control panel being configured displays r - and flashes the lower section of the Reverse Duct indicator. This parameter sets the middle position of the SLC or reverse control lever attached to the control panel. This option is not available for centre and inner Jet CPM's with shared lever control as their control lever signals are derived from the outer Jet panels (where the control lever module is attached).
13	Thrtle Fwd	0xa00 - 0xf80	0xf00		Max Throttle - Throttle Lever Signal. The control panel being configured displays t - This parameter sets the forward position of the throttle control lever attached to the control panel. This option is not available for centre and inner Jet CPM's with shared lever control as their throttle signals are derived from the outer Jet panels (where the throttle control lever module is attached), nor is it available to SLC systems.
14	Thrtle Back	0x80 - 0x500	0x100		Min Throttle - Throttle Lever Signal. The control panel being configured displays t - This parameter sets the idle position of the throttle control lever attached to the control panel. This option is not available for centre and inner Jet CPM's with shared lever control as their throttle signals are derived from the outer Jet panels (where the throttle control lever module is attached), nor is it available to SLC systems.
15	Helm2 Port	0x08-0x72	0x10		Full Port Helm Signal for Secondary Helm. As Port Helm parameter 7.

No	Parameter	Range	Default	Unit	Description
16	Helm2 Stbd	0x98-0xf8	0xf0		Full Starboard Signal for Secondary Helm. As Starboard Helm parameter 8.
17	Helm2 Mid	0x50-0xb0	0x80		Mid Position Signal for Secondary Helm. As Mid Helm parameter 9.
18	DCM Limits	N/A			Joystick Limits - DCM. The control panel being configured displays **o** . Select this parameter to set the outer limits on the DCM joystick. Each of the four characters represent one corner of the joystick movement and will change from a "." to an arrow when an appropriate value has been read.
19	DCM Centre	N/A			Joystick Centre - DCM. The control panel being configured displays **o-** Select this parameter to set the centre position on the DCM joystick. Four arrows will show when the joystick is centred. This option is only available on port outer Jet CPM's.
20	DCM Z Port	0x18			Joystick third axis port limit - DCM. Control panel being configured displays **hP** This parameter sets the limit of the joystick third axis travel in the port direction.
21	DCM Z Stbd	0x106			Joystick third axis starboard limit - DCM. Control panel being configured displays **hS** This parameter sets the limit of the joystick third axis travel in the starboard direction.
22	DCM Z Mid	0x67			Joystick third axis mid position- DCM. Control panel being configured displays **h-** This parameter sets the limit of the joystick third axis mid position.
23	DCM trim	-9.9-9.9	0.0		Helm Compensation Trim - DCM. Control panel being configured displays **ht** This parameter may be used to trim the rotation of the boat while in DCM mode. If the boat consistently rotates to port, increase this value. If the boat consistently rotates to starboard, decrease this value.
24	Jet sepr	1.0-99.9	3.5	Meters or Feet	Horizontal Jet separation at the Transom - DCM. Control panel being configured displays **S** This parameter must be set to the distance between centre lines of the two outer jet units. Both this parameter and 'Dist LCG' may be measured in Metres or Feet provided that both use the same units.
25	Dist LCG	4.0-99.9	10.0	Meters or Feet	Distance from the Transom to the boat centre of gravity - DCM. Control panel being configured displays **CG** See 'Jet sepr'. This parameter is typically not more than 45% of the boat water line length.
26	Deadrise	1.0-35.0	15.0	Degrees	Mounting angle of the Outer Jets from horizontal - DCM. Control panel being configured displays **dr** This parameter must be set to the mounting angle in degrees between the Jet Unit and the horizontal at the Transom. On a monohull this is normally the same as the aft deadrise.
27 (F)	AnalogFilt	0 - 16	12		Software Filter Applied to all Analogue Inputs.
28(F)	Dim Type	Lamp - LED	Lamp		CPM dimming ▪ Lamp – normal CPM module ▪ LED – NVIS CPM module
39(F)	CntrJetThtlEn	Yes – No	No		Center jet throttle and bucket is average of outer jets when dual levers are used for 3 jet system
30 (F)	LockDisable	yes-no	no		Disables control transfer locking. This parameter prevents the controls of that station from being locked.
31 (F)	NonZeroXfr	yes-no	no		Disables the need for the Reverse Lever to be in the 'Zero Speed' position for Control Transfer.

No	Parameter	Range	Default	Unit	Description
32 (F)	Beep Type	0x00 - 0x02	0x02		Sound of Audible Alarms. ▪ 0=Similar beep tone for all alarms. ▪ 1=Different beep tones for different alarms. ▪ 2= Different pulsing beep tones for different alarms.
33 (F)	ThLim maste	Yes-No	No		Limited Throttle Mode Master Station. This parameter sets which station has the throttle limitation feature. Under normal operation, the RPM is limited to the value set by "Throt limit". An override switch (connected to the port CPM at this station) enables 100% RPM.
34 (F)	Throt limit	50-100	100%		Limited Throttle Mode Throttle Limit. This parameter sets the maximum throttle under normal operation.
35 (F)	DCM X Max	0xa8 - 0xf8	0xf0		Fully Forward - DCM. This parameter is the maximum forward position of the joystick.
36 (F)	DCM X Min	0x08 - 0x38	0x10		Full Astern - DCM. This parameter is the maximum reverse position of the joystick.
37 (F)	DCM X Mid	0x50 - 0xb0	0x80		Centred - DCM. This parameter is the joystick mid position.
38 (F)	DCM Y Max	0xa80 - 0xf80	0xf00		Fully to port - DCM. This parameter is the maximum joystick displacement in the port direction.
39 (F)	DCM Y Min	0x080-0x380	0x100		Fully to starboard - dcm. This parameter is the maximum joystick displacement in the starboard direction.
40 (F)	DCM Y Mid	0x500-0xb00	0x800		Centred - DCM. This parameter is the joystick mid position.
41 (F)	DCM AsideTh	0 - 100	31%		Throttle Limit Sideways. This parameter sets the engine RPM at the maximum joystick port and starboard displacement.
42 (F)	DCM AheadTh	0 - 100%	15%		Throttle Limit Ahead. This parameter sets the engine RPM when the joystick is fully forward.
43 (F)	DCM AsternT	0 - 100%	15%		Throttle Limit Astern. This parameter sets the engine RPM when the joystick is fully backward.
44 (F)	DCM SLC th	0 - 100%	31%		Additional SLC Boost. This parameter sets how much additional engine RPM can be obtained from the joystick when the SLC levers are moved fully forward.
45 (F)	DCM HelmTh	0 - 100%	31%		Z axis throttle This parameter sets the maximum RPM available on the joystick Z axis
46 (F)	DCM Ramp t1	0.0 - 9.9	9.0		Throttle Acceleration. This parameter is the time in seconds for the RPM to go from idle to full when the joystick is moved from one side to the other.
47 (F)	DCM Fwd lim	0 - 100%	42%		50% thrust demand This parameter sets the position of the ahead Reverse Duct when moving sideways.
48 (F)	DCM CurvAhd	6 - 25%	12%		Sensitivity Ahead. This parameter sets the joystick sensitivity in the forward position. This is similar to the helm curve parameter.
49 (F)	DCM CurvAsi	31 - 84%	50%		Sensitivity Astern This parameter sets the joystick sensitivity in the reverse position. This is similar to the helm curve parameter.
50(f)	AP Overide	5-15	5	Degrees of steering	API is enabled (AP in Auto): Degrees of steering the helm wheel can be turned to disable the API
51(F)	Panel S/W V?.?	N/A			Software version.
52 (F)	Restore defaults				

JCM Setup Parameters

No	Parameter	Range	Default	Unit	Description
1 (A)	Starbd Db	30 - 60	39		Proportional Valve Deadband.
2 (A)	Port Db	30 - 60	36		Proportional Valve Deadband.
3 (A)	Stbd Fb	0xa0 - 0xf8	0xC8		Steering feedback when full to starboard.
4 (A)	Port Fb	0x08 - 0x60	0x32		Steering feedback when full to port.
5 (A)	Rev.Up Db	30 - 60	37		Proportional Valve Deadband.
6 (A)	Rev.Dn Db	30 - 60	38		Proportional Valve Deadband.
7 (A)	Rev.Up Fb	0x900-0xf80	0xd00		Reverse feedback when fully raised.
8 (A)	Rev.Dn Fb	0x80 - 0x600	0x250		Reverse feedback when fully lowered.
9	StrgMid Fb	0x50 - 0xa0	0x80		Steering feedback when straight ahead.
10	RevNeut Fb	0x200-0x900	0x500		Reverse feedback at zero thrust.
11 (F)	Steering Kp	1 - 32	28		Steering - Proportional Gain.
12 (F)	Rev. Up Kp	1 - 32	28		Reverse Up - Proportional Gain.
13 (F)	Rev. Dn Kp	1 - 32	28		Reverse Down - Proportional Gain.
14 (F)	Strg AlTime	1 - 40	3	Second	Steering alarm time-out / seconds.
15 (F)	Rev. AlTime	1 - 40	3	Second	Reverse alarm time-out / seconds.
16 (F)	Strg HydMax	50 - 120	110		Steering drive maximum - limits max. speed of movement.
17 (F)	Up HydrMax	50 - 120	110		Reverse up drive maximum - limits max. speed of movement.
18 (F)	Down HydMax	50 - 120	110		Reverse down drive maximum - limits max. speed of movement.
19 (F)	LinearRevMax	0 - 16	9		Max Linear Reverse Region. Used to set the upper limit of the linear region for duct positioning. Eg default - positions duct between 'down' and 9/16 'up' when manoeuvring.
20 (F)	SteeringErr	0 - 10	3		Min Steering Error. Determines positioning accuracy and alarm detection
21 (F)	ReverseErr	0 - 100	20		Min Reverse Error. Determines positioning accuracy and alarm detection.
22(F)	MaxOilTemp	0 - 127	65		Max Oil Temperature. More than this causes an alarm. 0 = disabled.
23 (F)	MinOilPr	0 - 100	3		Minimum In-Gear Oil Pressure. Less than this causes an alarm. 0 = disabled.
24 (F)	StrDbOff	0 - 8	2		Steering Deadband Offset. Added to deadband measured during Set-Up.
25 (F)	RevDbOff	0 - 8	2		Reverse Deadband Offset. Added to deadband measured during Set-Up.
26(F)	Bearing Temp	0 - 255	0		Bearing Temperature Sensor Option - 1 to 255 = enabled, 0=disabled. All settings from 1 to 255 have the same effect.
27 (F)	BrgOilLevel	0 -1	0		Bearing Oil Level Sensor Option - 1 = enabled, 0 = disabled.
28(F)	BrgOilPres	0 – 1	0		Bearing oil pump pressure sensor option, 0 = disabled 1 = enabled
29F	BrgSwDelay	5 – 15	5	Seconds	Bearing oil pump pressure switch alarm timeout / seconds
30 (F)	AnalogFilt	0 - 16	14		Software Filter Applied to all Analogue Inputs.
31 (F)	Integratn	0-31	12		Jet Hydraulics Control Response Parameter.
32 (F)	ExtrnHydrlc	0-1	0		External Hydraulic Pump Drive Option - 1= enabled, 0 = disabled.
33 (F)	JCM S/W V?.?				Software version.
34 (F)	Restore defaults				

ECM Setup Parameters

No	Parameter	Range	Default	Unit	Description
1	Eng Type	None DDEC Cumm MTU CatP User	MTU		Engine Type: Tells the ECM what type of engine it is connected to. The options are: ▪ None = No engine is connected. ▪ DDEC = DDEC. ▪ Cumm = Cummins. ▪ MTU = M.T.U. ▪ CatP = Caterpillar. ▪ User = User defined.
2	Thtle Type	None PWM Freq	PWM		Throttle Type Sets the primary throttle type.
3	PWM Freq	100 - 1000	500	Hz	PWM Frequency. Sets the frequency for PWM throttle types.
4	PWM Min	3 - 50	4	%	Minimum PWM Pulse Width. Sets the PWM duty cycle for idle RPM as a percentage (for PWM throttle types only).
5	PWM Max	20 - 97	96	%	Maximum PWM Pulse Width. Sets the PWM duty cycle for full RPM as a percentage (for PWM throttle types only).
6	Min Freq	50 - 500	100	Hz	Minimum Frequency for Variable Frequency Throttle Control. Sets the frequency for idle RPM (for frequency throttle types only).
7	Max Freq	100 - 1000	500	Hz	Maximum Frequency for Variable Frequency Throttle Control. Sets the frequency for full RPM (for frequency throttle types only).
8	Max Idle	0 - 100	25	%	Maximum Idle Setting As a % of Full Throttle. Sets the percentage of full RPM that the idle adjust buttons can raise the engine RPM to.
9	Max Rev	0 - 100	60	%	Minimum Throttle Demand Whilst in Reverse. Sets the percentage of full RPM that the engine can be raised to when the Reverse Duct is fully down.
10	Ramp Spd	0 - 10	2		Max Speed of Throttle Demand Increase. Sets the rate at which the engine can increase it's RPM. The range is: 0 to 10, where 0 is the slowest rate, 10 = fastest rate.
11	Alrm Tmp	0 - 255	110	°C	Temperature Above Which an Alarm is Generated. This parameter is for systems that have an engine temperature sensor connected to the ECM. Sets the temperature at which an Engine Temperature Alarm is given. The range is: 0 to 255 where 0 = sensor minimum, 255 = sensor maximum.
12	FBK Min	20 - 1000	40		RPM Feedback - Minimum Expected Value. Sets the minimum frequency for idle RPM feedback. Systems without gearboxes use the RPM signals to indicate the availability of hydraulic power.
13	FBK Max	0 - 1000	1000		RPM Feedback - Maximum Expected Value. Sets the maximum frequency for full RPM feedback.
14	Wmup Cntl	On/Off	Off		Warm Up Control On/Off. Turns on or off the 'Warm-up control' feature. When turned on it is possible to limit the RPM of the engine until the engine temperature has attained the required operating temperature. An engine temperature sensor must be connected to the ECM for this feature to operate.
15	Wmup Temp	0 - 255	40	°C	Warm Up Temperature. Sets the temperature below which the engine RPM is limited. This parameter only has an effect when Warm-up Control is turned on and an engine temperature sensor is connected to the ECM.

No	Parameter	Range	Default	Unit	Description
16	Wmup Rpm	0 - 40	25	RPM	Maximum Warm Up RPM. Sets the % of full RPM for which the engine is limited to while the engine temperature is too cold. This parameter only has an effect when Warm-up Control is turned on and an engine temperature sensor is connected to the ECM.
17	Idle Reset	On/Off	Off		Idle Reset on Full Throttle On/Off. Enables the Idle Reset Control. When turned on, this feature means that the idle RPM level is reset to minimum RPM when the control levers are moved to full ahead. When turned off, the idle RPM level is left at the level last set using the idle RPM buttons on a CPM.
18	Ttle Sync	On/Off	Off		Throttle Synchronisation On/Off. Enables the throttle synchronisation feature.
19	SyncThErr	0 - 8	3		Throttle Difference Allowable Before Throttle Synchronisation is Turned Off. Sets the allowed difference between throttle levers before throttle synchronisation is lost. This parameter is only applicable where the Throttle Synchronisation feature is enabled. The range is 0 to 8 where 0 means the levers must be in identical positions, an 8 means the levers may be widely separated before throttle synchronisation is lost.
20	Ttle Ilock	On/Off	On		Throttle / Reverse Duct Interlock On/Off. Enables the Reverse Duct / Throttle Interlock. The Reverse Duct / Throttle Interlock prevents the throttle from increasing when the Reverse Duct is up though the Reverse Lever is down, or vice versa. This situation arises when the lever is moved rapidly from full ahead to full astern (or astern to ahead) as it takes longer for the Reverse Duct to move than it does to move the lever.
21	Thrtle Los	On/Off	Off		Enables the 'Lost RPM Feedback Alarm'.
22	Clsd Loop	On/Off	Off		Closed Loop Throttle Control On/Off. Enables closed loop control of the throttle using the RPM feedback.
23	Gbx Type	None 1Sol 2Sol 3Sol 2Wir Actr	3Sol		Gearbox Type. Sets the type of gearbox that the ECM is connected to. The options are None = no gearbox fitted. ▪ 1Sol = 1 solenoid. ▪ 2Sol = 2 solenoid. ▪ 3Sol = 3 solenoid. ▪ 2Wir = 2 wire. ▪ Actr = actuator.
24	GbFbk Type	RPM 1Sig 2Sig 3Sig	3Sig		Gearbox Feedback Type. Sets the type of gearbox feedback that is connected to the ECM. The options are: RPM = An RPM feedback signal is considered to indicate the gearbox is in Drive. ▪ 1Sig = 1 signal. ▪ 2Sig = 2 signal. ▪ 3Sig = 3 signal. ▪ None = feedback is looped back from the Gearbox Position solenoid drive signals.
25	GbFbk Inv	0 - 7	0		Gearbox Feedback Inversion Bitmap. This parameter sets, which gearbox feedback signals, should be inverted. 0 = No signals inverted. ▪ 1 = Drive signal inverted only. ▪ 2 = Neutral signal inverted only. ▪ 3 = Drive and neutral signals inverted. ▪ 4 = Bkflush signal inverted only. ▪ 5 = Drive and bkflush signals inverted. ▪ 6 = Bkflush and neutral signals inverted. ▪ 7 = All signals inverted.
26	Mov Timout	0 - 10	6	Second	Movement Time-Out for Throttle Follow-Up Alarm. Sets the amount of time allowed between a gearbox drive

No	Parameter	Range	Default	Unit	Description
					signal and receiving the correct gearbox feedback.
27	Thrt2Idle	On-Off	On		Enables the 'throttle to idle' feature when an engine related alarm occurs.
28	A Fbk Drv	0 - 255	240		Analog Gearbox Feedback - Drive Position. Sets the feedback level required to indicate the gearbox is in drive when using an analogue feedback system.
29	A Fbk Ntl	0 - 255	127		Analog Gearbox Feedback - Neutral Position. Sets the feedback level required to indicate the gearbox is in neutral when using an analogue feedback system.
30	A Fbk Rev	0 - 255	16		Analog Gearbox Feedback - Reverse Position. Sets the feedback level required to indicate the gearbox is in backflush when using an analogue feedback system.
31	Maxgr Ttl	1 - 100	10	%	Max Throttle Signal at Which Gear Changes are Allowed. Sets the maximum level (in percentage of full throttle) the throttle can be set to before gear changes are prevented.
32	MaxGr Rpm	0 - 100	35	%	Max RPM Feedback Signal at Which Gear Changes are Allowed. Sets the maximum level (in percentage of full RPM feedback) the RPM feedback can get to before gear changes are prevented.
33	Ilock Rly	GBIl Trim Sync None	GBIl		Function Setting of the Auxiliary Relay. Sets the function of the auxiliary relay. It can be set as a gearbox interlock relay, a trim tab control relay or as a throttle synchronisation relay. The options are: ▪ GBIL = gearbox interlock. The relay will switch whenever the throttle lever is above the idle position. ▪ Trim = trim tab control. The relay will switch whenever the reverse duct is up and the gear is in the 'drive' position. It is intended that for multi jet installations the trim tab control circuit should be wired in series through each jets auxiliary relay. This ensures that the trim tab is only enabled when all jets are in the forward drive mode. ▪ Sync = throttle sync. The relay will switch whenever "throttle synchronisation" is enabled. Refer to Section 2.3.5 Throttle Synchronisation. This mode of operation is intended to be used with engines that provide a throttle synchronisation feature that require each engines electronic throttles to be connected together.
34(F)	Ilk DrvOn	Off – On	Off		Gearbox Interlock Relay to mimic Drive Relay
35(F)	RpmFbk	None - Shft	None		Jet shaft feedback, None – disabled, Shft - enabled
36(F)	EngIdleSpd	0 – 1000	500	RPM	Engine idle RPM (Jet shaft feedback enabled)
37(F)	EngMaxSpd	1200 – 3000	2005	RPM	Engine Max RPM (Jet shaft feedback enabled)
38(F)	EngIdleV	1000 – 3000	1303	mVolts	Jet shaft sensor interface voltage output (mVolts)
39(F)	FbkTmrVal	0 – 30	5	Seconds	Jet shaft feedback alarm timeout / seconds
40(F)	GB Ratio	1.00 – 9.99	2.17		Gearbox ratio : 1
41(F)	FbKRamp	0-200	25		Simulated RPM Increment and Decrement Rate. Used when there is no RPM signal.
42(F)	XhydEn	None Pos Neg Freq	None		External Hydraulic Pump Drive Signal Type. Can either be an active high or active low signal or a frequency input indicating when the pump is running.
43	RollShutd	Off-On	Off		Enables the Roll over Function
44	RollDelay	0-9.9	1	Seconds	Sets the delay before the Throttle is set to idle
45	RollGBOut	0.9.9	1	Seconds	Sets the delay before the gearbox is forced to neutral. This delay starts after RollDelay
46 (F)	ECM S/W V?.?				Software version.
47 (F)	RESTORE DEFAULTS				

API Setup Parameters

No	Parameter	Range	Default	Unit	Description
1	Dmnd Type	none Digl Anag	Digl		Select the Auto Pilot Steering Demand Type. Sets the type of helm demand that the autopilot supplies
2	Station	1-8	1		Set the station the API is active from If set to 'Any' the API is active at all connected stations
3	Strg Speed	1 - 20	4		Set the Steering Deflection Speed. Sets the speed that the steering nozzle moves away from mid position for digital demand type autopilots. The range is: 1 to 20 where 1 is the slowest possible speed and 20 is the fastest possible.
4	Retn Speed	1 - 20	4		Set the Steering Return Speed. Sets the speed that the steering nozzle returns to mid position for digital demand type autopilots. The range is: 1 to 20 where 1 is the slowest possible speed and 20 is the fastest possible.
5	MID DmdSig	200 - 300	100		Set the Mid Helm Steering Demand Signal for Analog Demand Systems. Lets the A.P.I. know what signal will be supplied by the auto pilot for steering mid position. This is required for analog demand type autopilots only. The range is: 200 to 300
6	PORT DmdSig	120 - 300	160		Set the Full to Port Steering Demand Signal for Analog Demand Systems. Lets the A.P.I. know what signal will be supplied by the auto pilot for full to port steering. This is required for analog demand type autopilots only.
7	STBD DmdSig	20 -80	40		Set the Full to Starboard Steering Demand Signal for Analog Demand Systems. Lets the A.P.I. know what signal will be supplied by the autopilot for full to starboard steering. This is required for analog demand type autopilots only
8	Fbk Type	None Freq PWM	Freq	Hz	Select the Auto Pilot Steering Position Feedback Signal Type. Sets the type of feedback signal that the autopilot requires.
9	Pwm Freq	100 - 4000	500	Hz	Set the Feedback PWM Frequency. Sets the frequency of the PWM feedback signal for autopilots that require a PWM feedback signal.
10	PwmFd Min	5 - 200	78		Set the Minimum PWM Allowed. Sets the pulse width of the PWM feedback signal required for steering nozzle full to port position. This is only used for autopilots that require a PWM feedback signal. The range is: 5 to 250 where 5 gives a pulse width of 1%, 250 gives a pulse width of 99%.
11	PwmFd Max	20 - 250	178		Set the Maximum PWM Allowed. Sets the pulse width of the PWM feedback signal required for steering nozzle full to starboard position. This is only used for auto pilots that require a PWM feedback signal. The range is: 20 to 250 where 20 gives a pulse width of 10%, 250 gives a pulse width of 99%.
12	FreqFb Min	100 -4000	2800	Hz	Set the Minimum Frequency Allowed. Sets the feedback frequency required for steering nozzle full to port position. This is only used for autopilots that require a frequency feedback signal. The range is: 100 to 4000 Hz

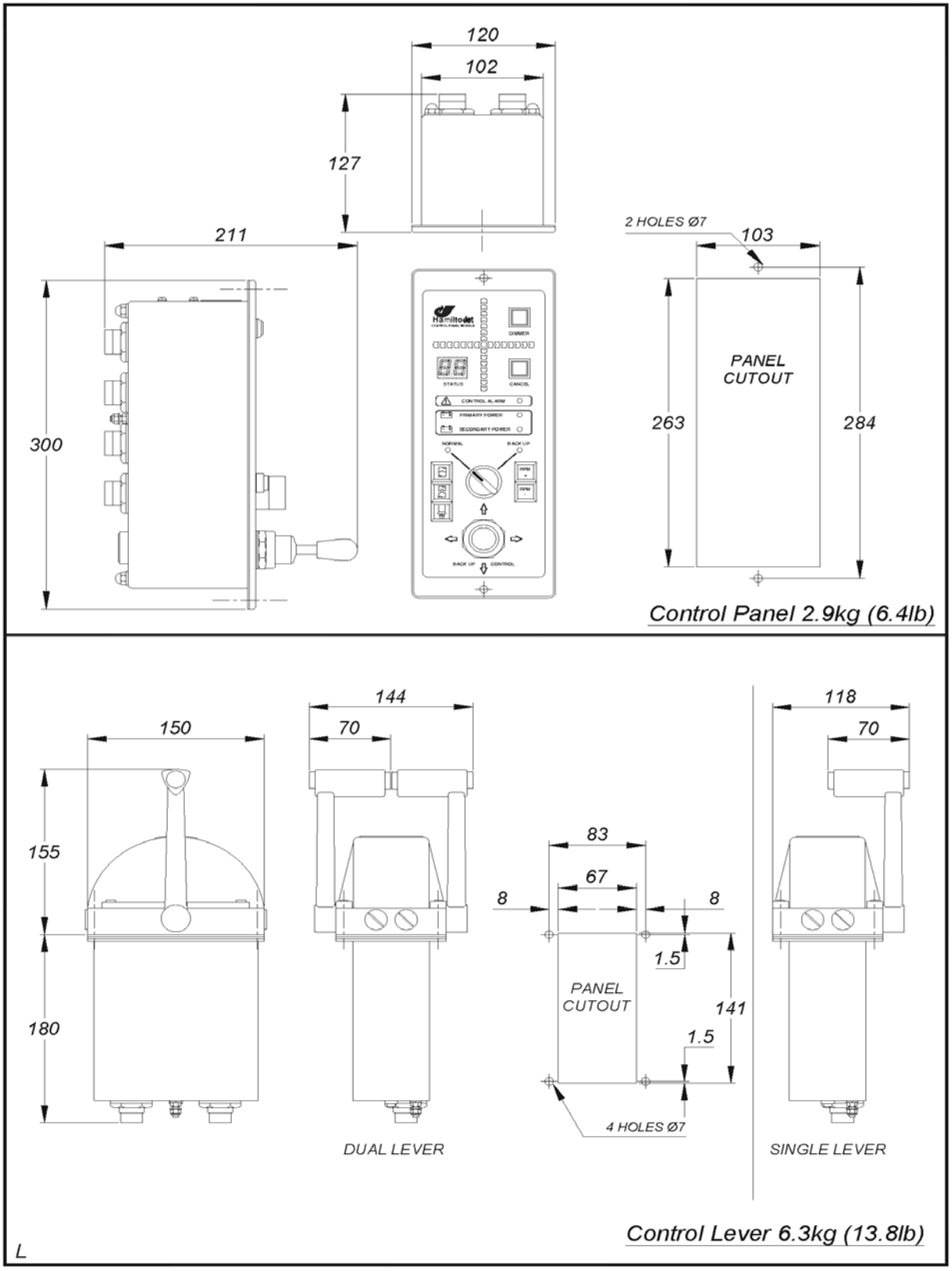
No	Parameter	Range	Default	Unit	Description
13	FreqFb Max	100 - 7000	4000	Hz	Set the Maximum Frequency Allowed. Sets the feedback frequency required for steering nozzle full to starboard position. This is only used for autopilots that require a frequency feedback signal.
14 (F)	AnSigInvrt	0 - 1	0		Set the Analog Demand Inversion Bits.
15 (F)	DgSigInvrt	0 - 255	0		Set the Digital Inversion Bits.
16 (F)	AnFbkInvrt	0 - 1	0		Set the Analog Feedback Inversion Bits.
17 (F)	Ang Dmd Db	0 - 20	4		Set the Level of Demand Dead Band.
18 (F)	AnalogFilt	0 - 16	1		Set the Analog Filter Level.
19 (F)	API S/W V?.?				Software Version.
20 (F)	RESTORE DEFAULTS				

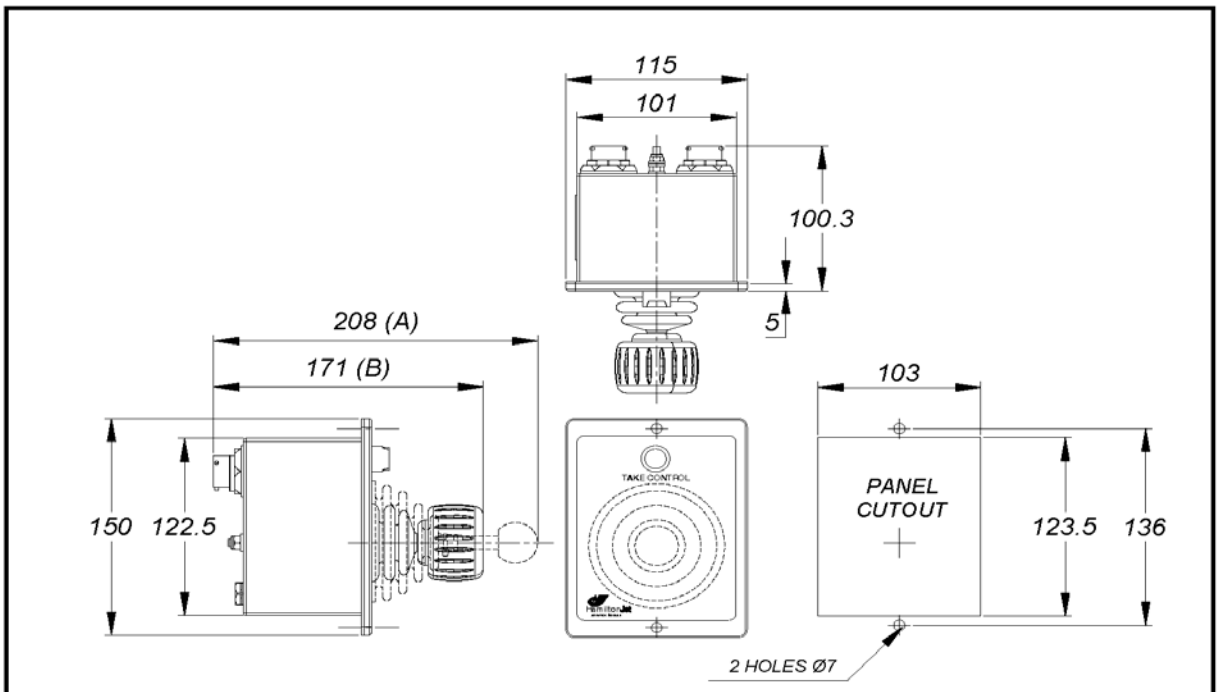
DPI Setup Parameters

No	Parameter	Range	Default	Unit	Description
1	A/B used	A, B A + B	A		Defines which DPI interfaces are enabled - A, B or both.
2	Station	Any 1 - 8	1		If value is 'Any', DP mode can be enabled when control is at any station and control transfer can take place while in DP mode.If value is 1- 8, control must be at the specified station before DP mode can be enabled. Control transfer is then disabled in DP Mode.
3	PORT Azim-A	0x1-0xc00	0x2e0		Minimum commanded azimuth signal (equiv. to -180°) Channel A.
4	STBD Azim-A	0x3e8- 0xfff	0xec6		Maximum commanded azimuth signal (equiv. to +180°) Channel A.
5	MID Azim-A	0x1-0xd48	0x8d0		Mid commanded azimuth signal (equiv. to 0°) Channel A.
6	MIN ThrustA	0x1-0xfff	0x980		Min. commanded thrust signal (equiv. to zero thrust) Channel A.
7	MAX ThrustA	0x3e8-0xfff	0xebb		Max. commanded thrust signal (equiv. to 100% thrust) Channel A.
8	PortA AzFbk	0x1-0xdac	0x120		Minimum azimuth feedback signal (equiv. to -180°) Channel A.
9	StbdA AzFbk	0x1-0xfff	0xebb		Maximum azimuth feedback signal (equiv. to +180°) Channel A.
10	MidA Az Fbk	0x1-0xfff	0x7e9		Mid azimuth feedback signal (equiv. to 0°) Channel A.
11	Min ThrAFbk	0x1-0xfff	0x8ae		Minimum thrust feedback signal (equiv. to zero thrust) Channel A.
12	Max ThrAFbk	0x1-0xfff	0xea4		Maximum thrust feedback signal (equiv. to 100% thrust) Channel A.
13	PORT Azim-B	0x1-0xc00	0x2e0		Minimum commanded azimuth signal (equiv. to -180°) Channel B.
14	STBD Azim-B	0x3e8-0xfff	0xec6		Maximum commanded azimuth signal (equiv. to +180°) Channel B.
15	MID Azim-B	0x1-0xdac	0x8d0		Mid commanded azimuth signal (equiv. to 0°) Channel B.
16	MIN ThrustB	0x1-0xfff	0x980		Min. commanded thrust signal (equiv. to zero thrust) Channel B.
17	MAX ThrustB	0x3e8-0xfff	0xebb		Max. commanded thrust signal (equiv. to 100% thrust) Channel B.
18	PortB AzFbk	0x1-0xfff	0x120		Minimum azimuth feedback signal (equiv. to -180°) Channel B.
19	StbdB AzFbk	0x1-0xfff	0xebb		Maximum azimuth feedback signal (equiv. to +180°) Channel B.
20	MidB Az Fbk	0x1-0xfff	0x7e9		Mid azimuth feedback signal (equiv. to 0°) Channel B.
21	Min ThrBFbk	0x1-0xfff	0x8ae		Minimum thrust feedback signal (equiv. to zero thrust) Channel B.

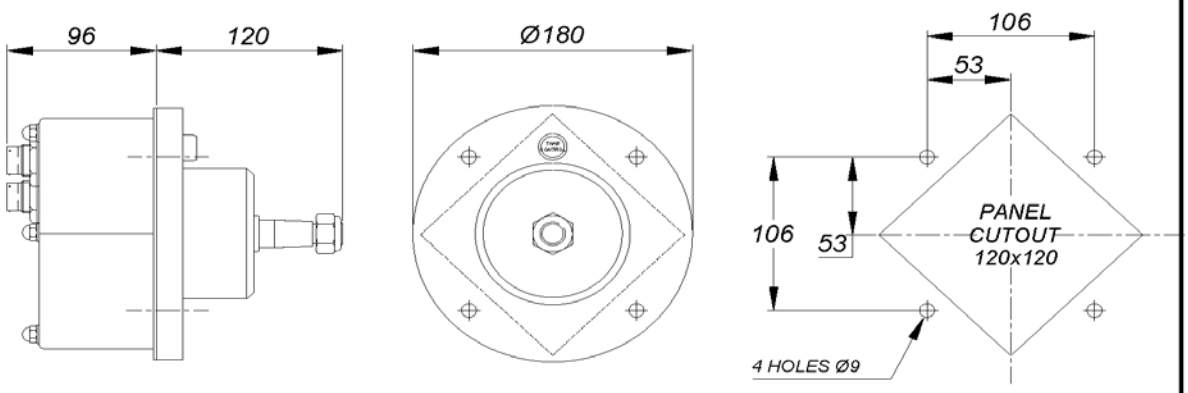
No	Parameter	Range	Default	Unit	Description
22	Max ThrBFbk	0x1-0xfff	0xea4		Maximum thrust feedback signal (equiv. to 100% thrust) Channel B.
23	DgSigInvrt	0-0xff	0		Invert digital inputsBit 0 = not usedBit 1 = DP A mode ONBit 2 = DP A mode OFFBit 3 = DP B mode ONBit 4 = DP B mode OFFBits 5-15 not used.
24	AnDmdInvrt	0-3	0		Invert analogue demand signals0 = No inversion1 = Invert azimuth demand2 = Invert thrust demand3 = Invert azimuth and thrust demand.
25	AnFbkInvrt	0-3	0		Invert analogue feedback signals0 = No inversion1 = Invert azimuth feedback2 = Invert thrust feedback3 = Invert azimuth and thrust feedback.
26	Ang Dmd Db	0-20	4		Deadband for azimuth normalization calculations.
27	AnalogFilt	1-15	8		Weighting of filter on analogue inputs. 1 = maximum filtering.
28	JetDefault	FIVE71 SIX51 SEVEN21 EIGHT11	SIX51		Jet model.
29	IdleThrust	1-50	14	%	Thrust at idle RPM/Thrust at max RPM in %.
30	SP	800-1200	918	mm	Jet geometry parameter.
31	RP	400-700	524	mm	Jet geometry parameter
32	CP	500-700	590	mm	Jet geometry parameter
33	MP	150-350	245	mm	Jet geometry parameter
34	Epsilon	480-680	583	° x 10	Jet geometry parameter
35	CHI	500-700	604	° x 10	Jet geometry parameter
36	RS	350-550	446	mm	Jet geometry parameter
37	RCMIN	100-300	203	mm	Jet geometry parameter
38	NR	100-300	180	mm	Jet geometry parameter
39	DUCT EFF	40-100	75	%	Jet geometry parameter
40	DUCT ALPHA	200-450	330	° x 10	
41	DUCT DELTA	150-400	250	° x 10	
42	STRG LIM	100-400	257	° x 10	
43	STROKE MIN	0-100	8	mm	Maximum steering angle in normal control mode.
44	STROKE CUT	0-300	120	mm	Reverse cylinder stroke when bucket fully raised in normal control mode.
45	STROKE MID	0-400	170	mm	Reverse cylinder stroke when bucket just above jet stream.
46	STROKE ZS	0-600	256	mm	Reverse cylinder stroke at zero speed.
47	STROKE MAX	0-600	334	mm	Reverse cylinder stroke when bucket fully down in normal control mode.
48	STRG Slope	0-200	90		Ratio of sway force to steering angle.
49	REV Slope	0-100	14		Ratio of surge force to reverse cylinder stroke.
50	SensrPivot	100-1000	144	mm	Height of reverse cylinder shaft axis above sensor pivot.
51	RpmBucktUp	0-100	100	%	RPM above which the bucket will go to fully raised when azimuth demand is in the range -StrgLim to +StrgLim. 0% = idle RPM 100% = Max RPM.
52	GboxDisble	0-1	0		Not used.
53	Flsh Chksm	0-255	127		TMS320 flash memory checksum.
54	DPI S/W v ?.?	0-255	127		DPI software version.

MECS Module Dimensions





A) Steering Joystick 1.6kg (3.5lb)
B) Maneuvering Joystick 1.28kg (2.8lb)



Helm Wheel Module 5.2kg (11.6lb) With Wheel 7.7kg (17lb)

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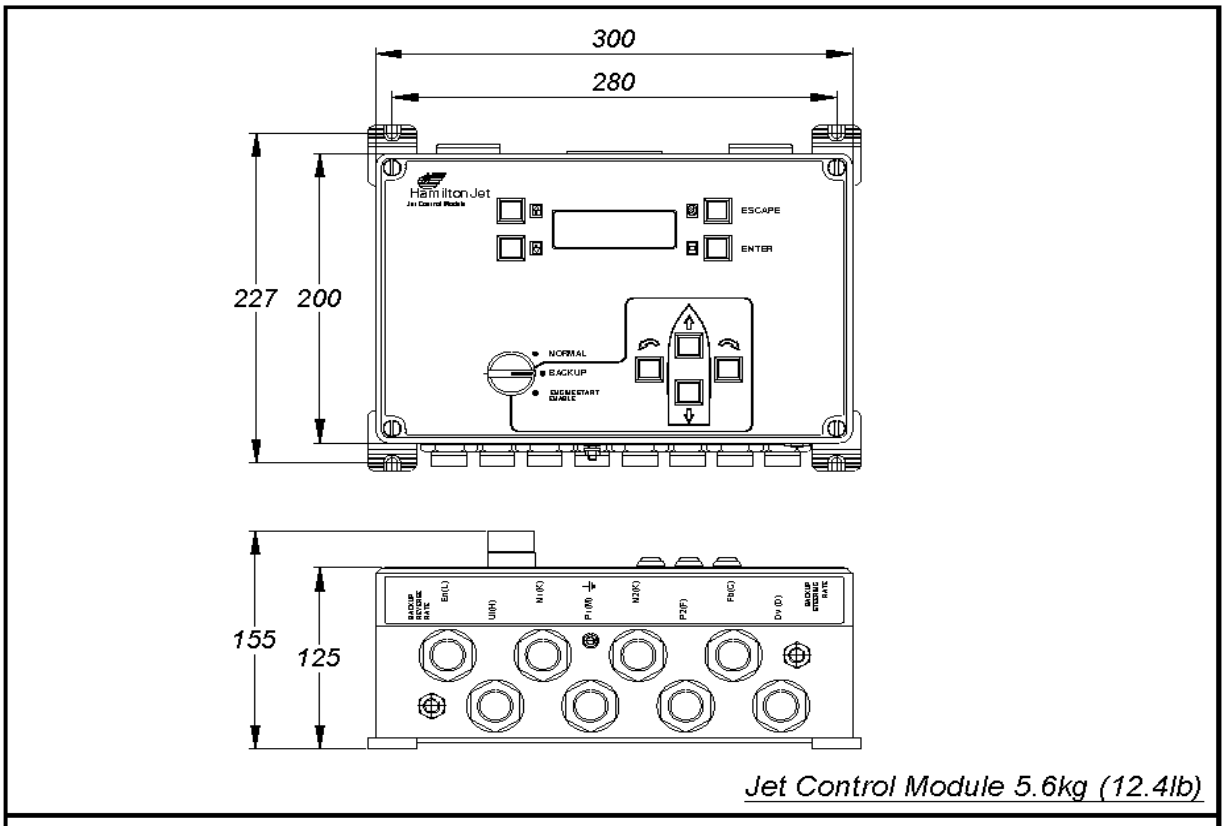
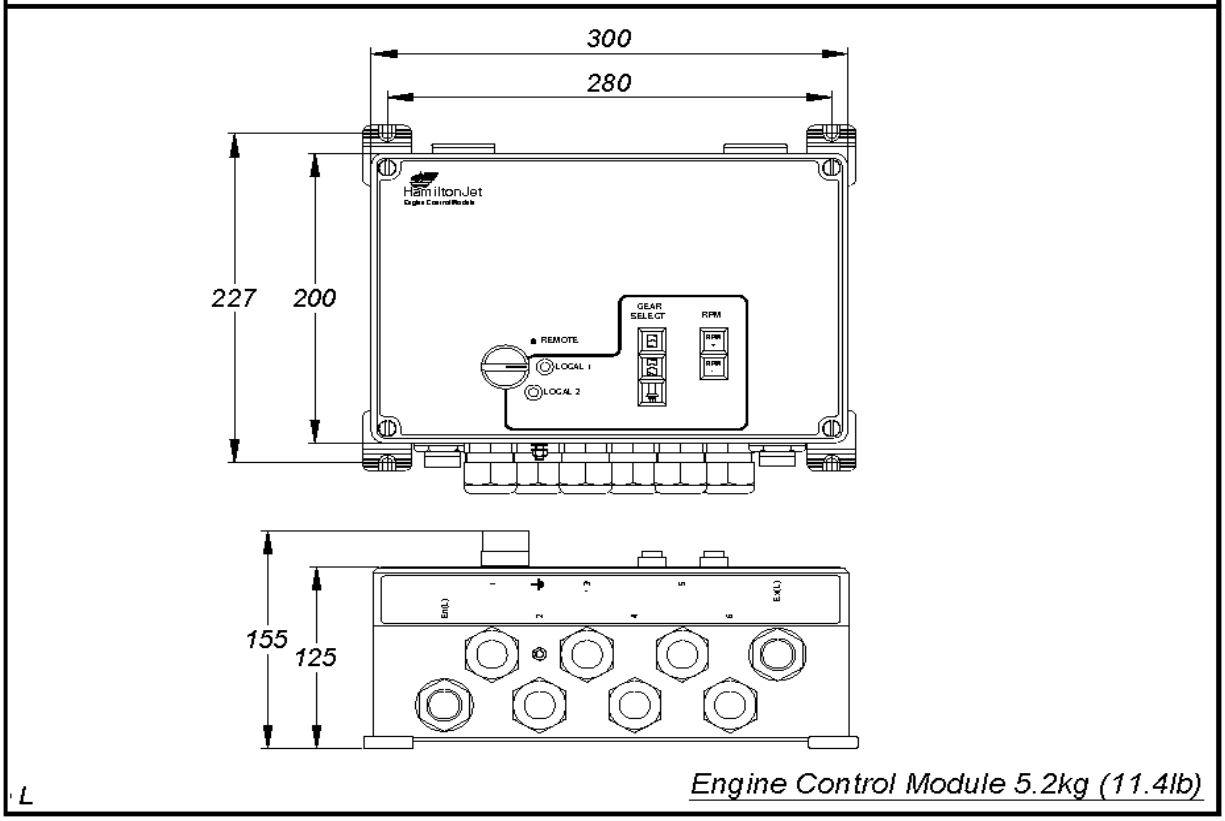


Jet Control Module 5.6kg (12.4lb)



Engine Control Module 5.2kg (11.4lb)

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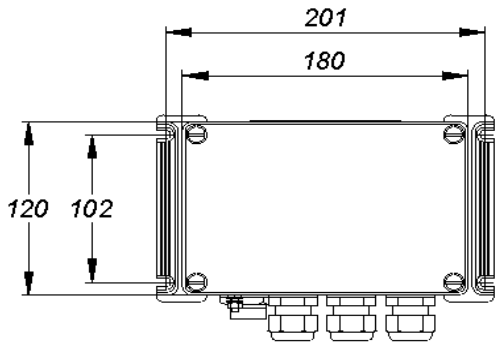
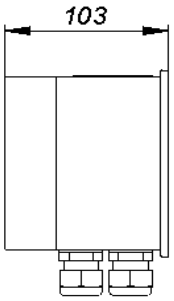
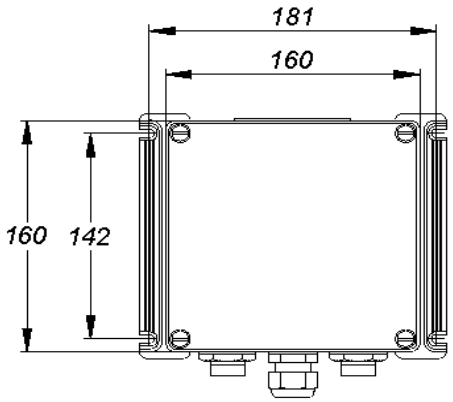
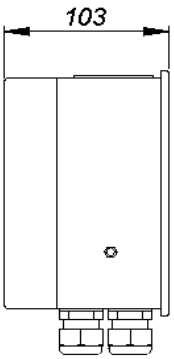




Power & Interlock Module 2.5kg (5.5lb)





Autopilot Interface Module 2.5kg ((5.5lb)

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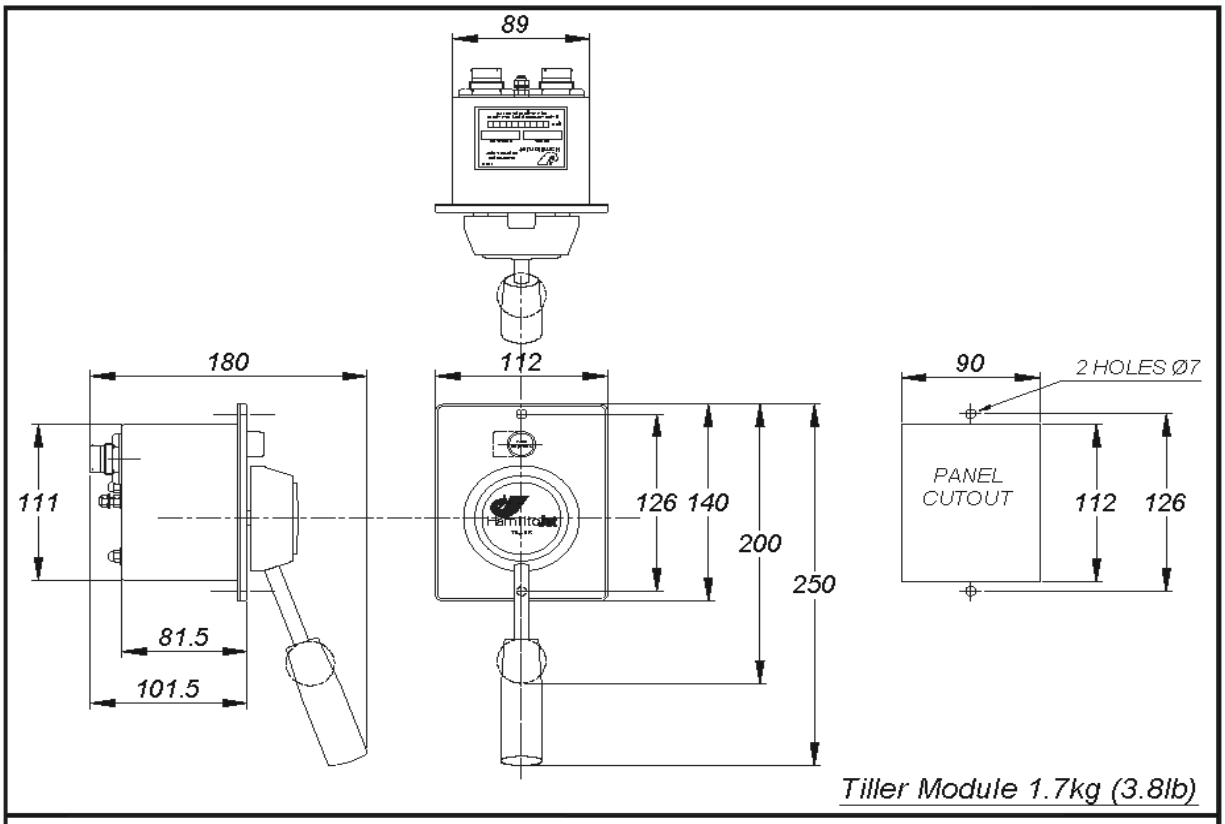
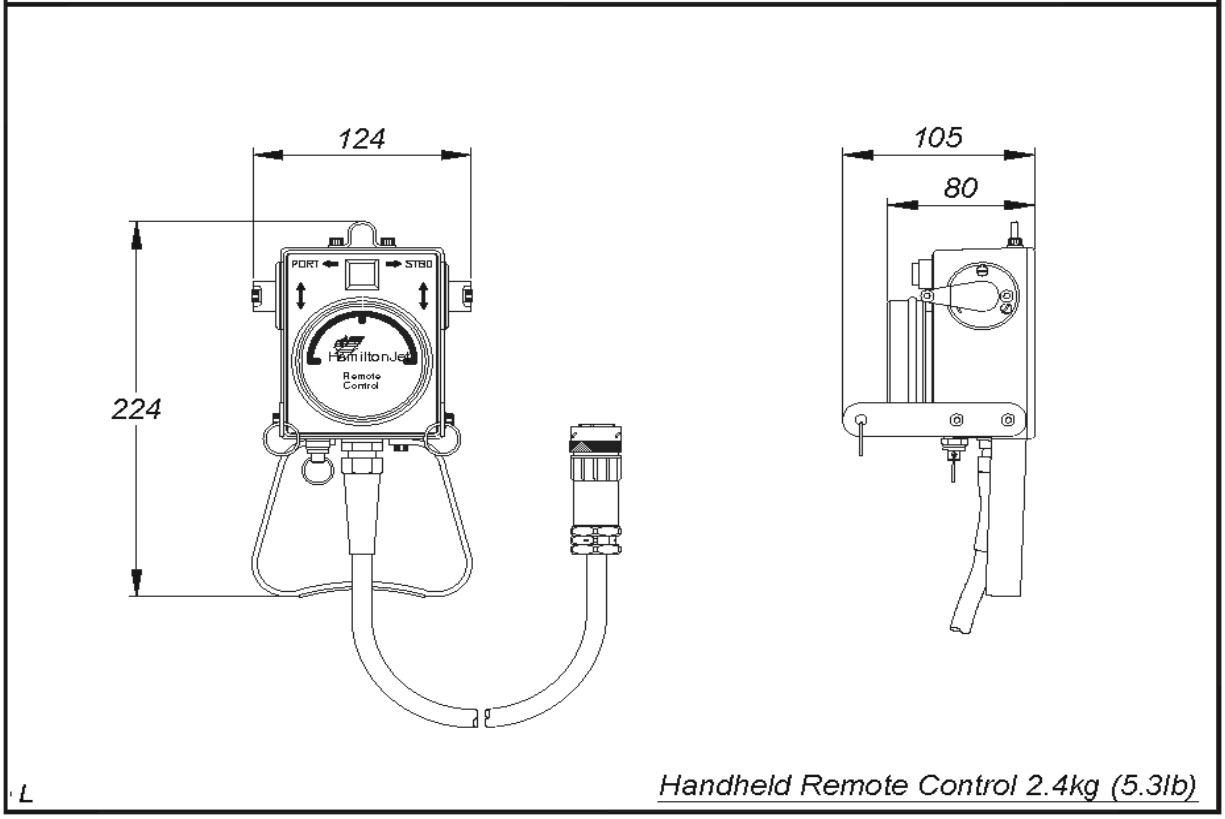


Tiller Module 1.7kg (3.8lb)



Handheld Remote Control 2.4kg (5.3lb)

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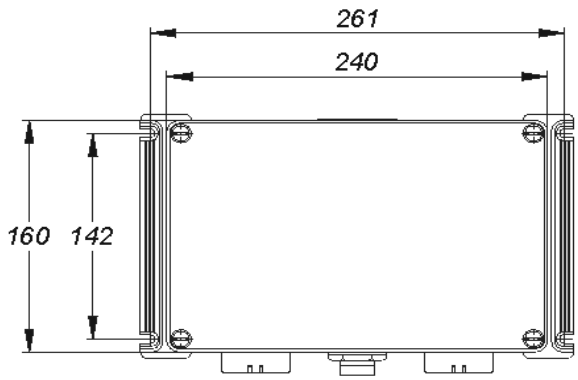
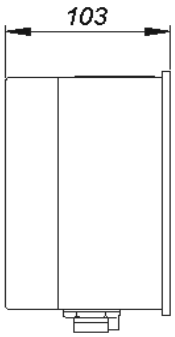
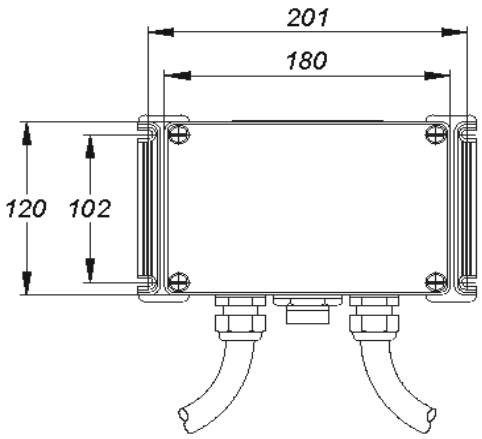
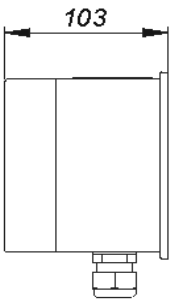




Dynamic Positioning Interface Module 2.7kg (5.9lb)





Handheld Remote Junction Box 3.4kg (7.5lb)

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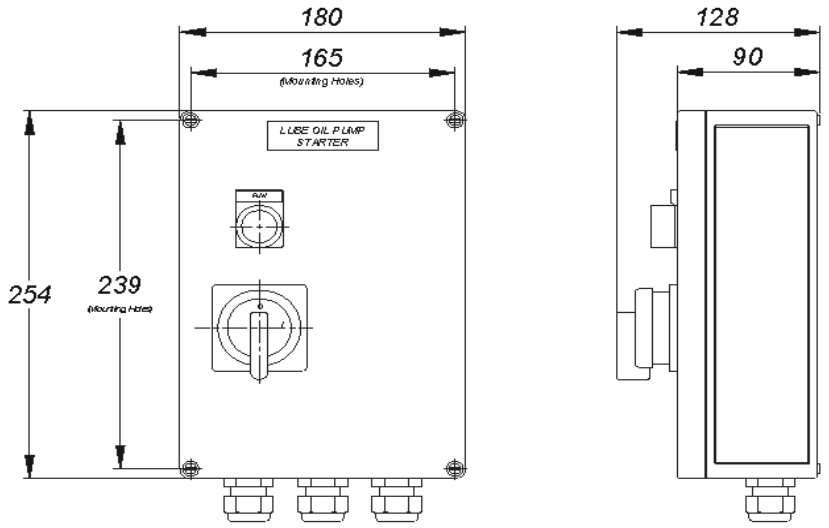
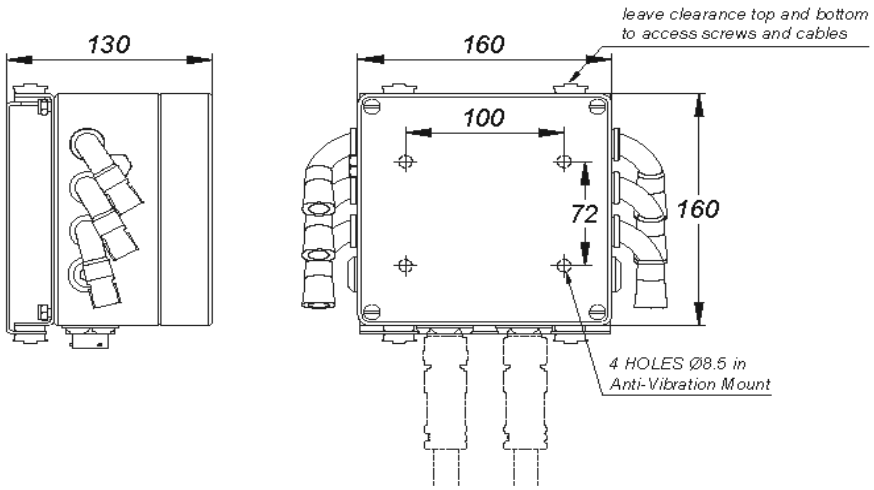


Oil Pump Starters 1.4kg (3lb)



Jet Junction Box

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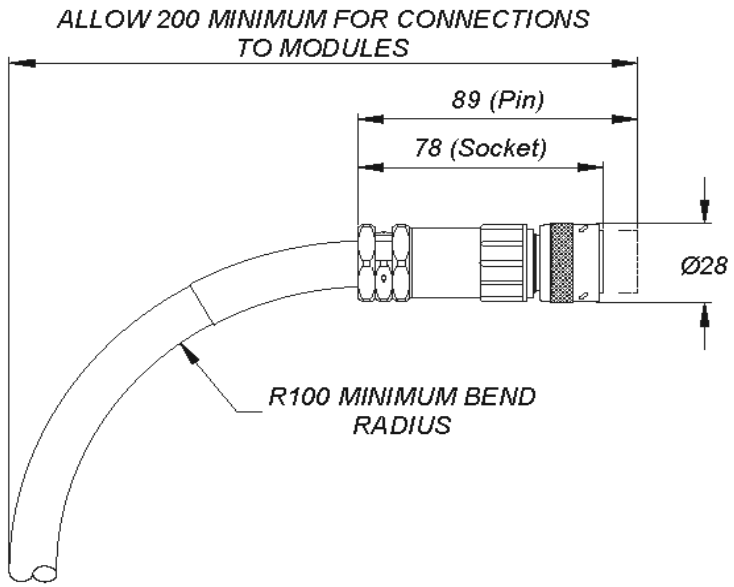
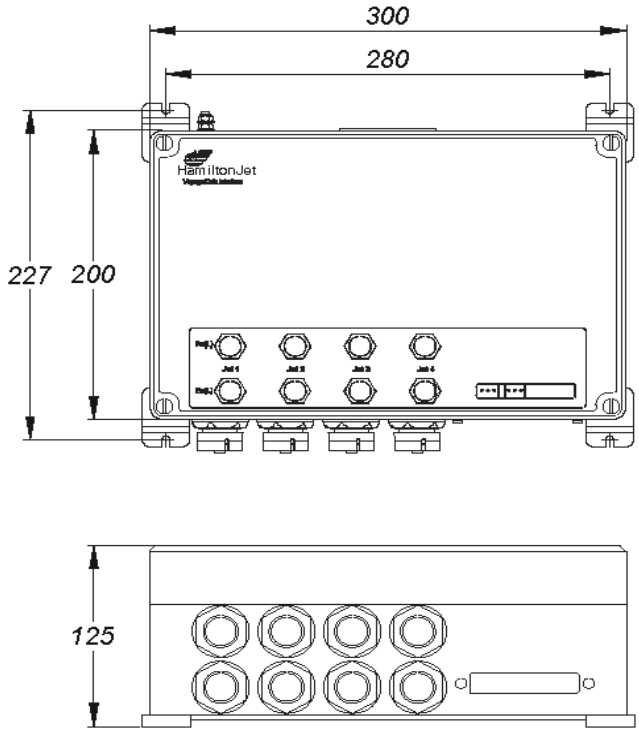


Connector Dimensions, Cable Weight = 0.4kg/m (0.3lb/ft)



Voyage Data Recorder
Interface Module

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MECS Spare parts

Part #	Description	Comments
CTITF01004	Auto-Pilot Interface Module	
CTCLV04009	Control Lever Module	
CTCPL14010	Control Panel Module.	
CTPCB09005	Engine Control Module	
111355	Engine Control Module Circuit Boards and Mounting Bracket Spares Assembly	
CTCPL14004	Hand Held Remote	
CTITF04004	Hand Held Remote Junction Box	
CTHLM08007.	Helm Wheel Module	
CTHLM05009	Tiller Module	Specify handle length (Long or Short) when ordering
CTITF03004	Jet Junction Box	
111358	Jet Junction Box Circuit Board and Mounting Bracket Spares Assembly	
CTPCB09008	Jet Control Module	
CTHLM05004	Joystick Module	Specify spring centred or friction lock when ordering
CTCLV07002	Manoeuvring Joystick Module	
CTITF04002	Power and Interlock Module	
CTWIR10101	Cable complete with connectors	Specify Cable length and polarisation when ordering
64944	12V Bulb	Used on the CPM, HHR, Joystick and Helm
64945	24V Bulb	Used on the ECM
64618	Bulb removal tool	Required to change bulbs
65014	Joystick boot.	
110190	CPM terminating plug.	

Module Lamp Replacement Details

Module	Part #	Size	Base	V	A
Control Panel Module	64944	T-1 ¾	Subminature Wedge	14v	80mA
Engine Control Module	64945	T-1 ¾	Subminature Wedge	28v	40mA
Take Control Light	64855	T-1 ¾	Midget Groove	14v	80mA
Lube Pump Starter	64387	T-3 ¾	Subminature Wedge	28v	80mA

MECS Technical Data

Jet Control Module

General

Module Name	Jet Control Module
Part Number	CTPCB09008
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Jet Control Module (JCM) is normally mounted in the engine or jet compartment. It can be considered as the 'hub' of a MECS distributed control system and performs the following functions: ▪ Power distribution and fusing for other modules. ▪ Normal and backup control of the steering and reverse hydraulics on the Jet Unit. ▪ Provides a central point for setting up and configuring the system. ▪ Logs alarms. ▪ Allows Normal/'Back-Up' switching. ▪ Allows local 'Back-Up' control.
User Controls	4 x pushbuttons operate in conjunction with display: - -Up arrow -Down arrow -Escape -Enter 3 position rotary mode switch controls: - -Normal/Backup Mode -Manual override of engine start interlock 4 x pushbuttons for backup control of jet reverse and steering 2 x rotary potentiometers for control of backup steering and reverse cylinder speeds located on enclosure bottom.
Display	4 line x 20 character backlit liquid crystal display (LCD)

Performance

Data Rates	Closed loop control update rate: 25 Hz Network communications data rate: 41.666 KBaud Maximum network message rate: > 8Hz Minimum network message rate: 1Hz
Time to operation from power up	Less than 2s
Control Accuracy	Reverse and steering: +/- 0.4% of cylinder stroke
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	24V Nominal. Variation -25% to +30%
Power consumption	Normal: typically less than 0.5A Maximum: typically less than 3A

Electrical Protection	Over voltage and reverse polarity protection provided. Internal fuses are all solid state and reset automatically on module power-down.
Connections	All electrical connections via 12 way two-part bayonet type connectors. Connectors are: - Connector — Description En — Engine Control Module connection Ui — Power/Interlock Module connection N1 — Link Network connection 1 P1 — Panel connection 1 N2 — Link Network connection 2 P2 — Panel connection 2 Fb — Feedback connection to Jet Junction Box Dv — Drive connection to Jet Junction Box Connector identification: Polycarbonate label on lower edge of front cover. Separate earth stud.

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	310 x 155 x 240. For Mounting hole detail Refer Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	5.6
Mounting method	Bulkhead mounting, external feet 4 x M6 bolts
Enclosure material	Aluminium die-cast: G Al Si 12 / DIN 1725, Leg. 230
Surface finish	Structure paint + baked enamel finish, stone grey RAL 7032. Polyester overlay on front cover.
Enclosure gasket	Neoprene, oil and petrol resistant (-30deg C to 100 deg C)
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	+5 to +55 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency — Amplitude — Acceleration 3 – 13.2 Hz — 1.0 mm peak 13.2 – 100 Hz — 0.7 g
EMC	Test Type — Test Basis Electrostatic discharge — IEC 61000-4-2 Radiated susceptibility — IEC 61000-4-3 Conducted low frequency — IEC 60945 Conducted radio frequency — IEC 61000-4-6 Burst/fast transients — IEC 61000-4-4 Surge/slow transient — IEC 61000-4-5 Radiated emissions — EN 50081-2 Conducted emissions — EN 50081-2
Degree of protection	IP 44

Control Panel Module

General

Module Name	Control Panel Module
Part Number	CTCPL14008
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	Control Panel Modules are mounted wherever control of a jet is required. A separate CPM is provided for each jet at each control station. It performs the following functions: - ▪ Jet steering and reverse position indication. ▪ MECS alarm and status indication (audible and visual). ▪ Back-up control of steering, reverse and throttle. ▪ Allows Normal/'Back-Up' switching. ▪ Control of gearbox. ▪ Display and lamp dimming control.
User Controls and Indicators	Dimmer pushbutton provides 5 dimming levels of panel and helm lamps and indicators. Alarm Cancel pushbutton silences alarm sounder to acknowledge an alarm condition. Can also be pressed to test all lamps. LED 'cross' indicates positions of jet steering deflector and reverse duct. 2 – digit, 7 – segment display indicates alarm code or system status. Control Alarm LED indicates when an alarm is detected. Primary power LED. ON = power OK, Flashing = power fault Secondary power LED. ON = power OK, Flashing = power fault. Normal/Backup LED's indicate control mode Normal/Backup switch to change control mode Gearbox Drive, Neutral, Backflush combined pushbutton and lamps. Combined Engine idle adjust (Normal mode) and RPM increment/decrement (Backup mode) pushbuttons. Four way jog switch for backup control of reverse and steering. Forward facing/aft facing panel selector switch on rear of panel. Alarm sounder on rear of panel.

Performance

Data Rates	Closed loop control update rate: 25 Hz CAN network communications data rate: 41.666 KBaud RS485 network communications data rate: 9600bps Maximum network message rate: > 8Hz Minimum network message rate: 1Hz
Time to operation from power up	Less than 2s
Control Accuracy	Steering input ADC resolution: 8bit Reverse input ADC resolution: 12bit
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	24V Nominal. Variation -25% to +30%
Power consumption	Normal: typically less than 0.15A Maximum: typically less than 0.40A (during lamp test)
Electrical Protection	Fusing, over voltage and reverse polarity protection provided via Jet Control Module.
Connections	All electrical connections via 12 way two-part bayonet type connectors on rear of panel. Connectors are: - Connector — Description R1 — Remote panel connection 1 R2 — Remote panel connection 2 J1 — JCM connection 1 J2 — JCM connection 2 Nx — Network expansion connection Rv — Reverse lever connection Th — Throttle lever connection Hlm — Helm connection Connector identification: Polycarbonate labels on panel rear. Separate earth stud.

Mechanical

Dimensions overall (± 5mm) **W x D x H (mm)**	120 x 210 x 300. For Mounting hole detail Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	2.9
Mounting method	Console mounting vertical or horizontal 2 x M6 screws.
Enclosure material	Front plate: machined 5083 aluminium plate Rear cover: fabricated 316 stainless steel sheet
Surface finish	Front plate: Anodised bright black 25 micron thick, polycarbonate overlay on front cover. Rear cover: polished
Enclosure gasket	EDPM foam gasket seals rear cover to front plate and front plate to console.
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environment

Ambient temperature	-25 to +70 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 56 when sealed to control console. For deck mounted control panels it is recommended that a sealed hard cover is always fitted over the panels when not in use.

Engine Control Module

General

Module Name	Engine Control Module
Part Number	CTPCB09005
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Engine Control Module (ECM) is normally mounted in the engine or jet compartment. It performs the following functions: ▪ Generation of the normal electronic throttle signal. ▪ Generation of the Backup throttle signal. ▪ Control of the gearbox solenoids. ▪ Interpretation of the gearbox feed back signals. ▪ Provides engine and gearbox safety interlocks
User Controls	3 position rotary mode switch controls: - -Remote (Normal) operation -Local control of gearbox and engine using normal throttle. -Local control of gearbox and engine using backup throttle. 5 pushbuttons that operate in conjunction with the rotary switch: - -Illuminated gearbox 'Drive' engagement -Illuminated gearbox 'Neutral' engagement -Illuminated gearbox 'Backflush' engagement -Engine rpm increment -Engine decrement

Performance

Data Rates	Control update rate: 25 Hz CAN network communications data rate: 41.666 KBaud Maximum network message rate: > 8Hz Minimum network message rate: 1Hz
Time to operation from power up	Less than 2s
Control Accuracy	Engine throttle output signal error: Less than 1%
Calibration	Module is calibrated via dip switches and potentiometers. Refer to the MECS manual.

Electrical

Operating voltage	24V Nominal. Variation -25% to +30%
Power consumption	Normal: typically less than 0.3A Maximum: typically less than 0.4A
Electrical Protection	Over voltage protection provided. Internal fuses are all solid state and reset automatically on module power-down.

Connections	Six cable glands for user connection plus two 12 way two-part bayonet type connectors. Wiring is to be according to the system wiring diagram. Connectors are: - Name — Description En — Jet Control Module connection Nx — Network expansion connection Connector identification: Polycarbonate label on lower edge of front cover.

Internal Terminal User Connections:		
Terminal No.	I/O	Description
1	Input	'Drive' feedback
2	Input	'Neutral' feedback
3	Input	'Backflush' feedback
4	Input	Engine 'Local control' feedback
5	Input	Gearbox +24V
6	Input	Gearbox 'Interlock' feedback
7	Relay contact	Backflush solenoid drive (COM)
8	Relay contact	Backflush solenoid drive (N/O)
9	Relay contact	Neutral solenoid drive (N/C)
10	Relay contact	Neutral solenoid drive (N/O)
11	Relay contact	Neutral solenoid drive (COM)
12	Relay contact	Drive solenoid drive (N/C)
13	Relay contact	Drive solenoid drive (N/O)
14	Relay contact	Drive solenoid drive (COM)
15	Relay contact	Normal/Backup relay no 1 (COM)
16	Relay contact	Normal/Backup relay no 2 (COM)
17	Relay contact	Normal/Backup relay no 1 (N/O)
18	Relay contact	Normal/Backup relay no 1 (N/C)
19	Relay contact	Normal/Backup relay no 2 (N/O)
20	Relay contact	Normal/Backup relay no 2 (N/C)
21	Relay Contact	Backflush solenoid drive (N/C)
22	Relay Contact	'Engine start' relay (N/O)
23	Spare	
24	Relay Contact	'Gearbox interlock' relay (N/C)
25	Relay Contact	'Gearbox interlock' relay (COM)
26	Relay Contact	'Gearbox interlock' relay (N/O)
27	Input	'rpm' feedback (COM)
28	Input	'rpm' feedback
29	Output	+24V aux output
30	Output	0V
31	Output	Open drain primary throttle signal
32	Output	Primary throttle signal
33	Output	Primary throttle (COM)
34	Relay Contact	'Engine start' relay (N/C)
35	Relay Contact	'Engine start' relay (COM)
36	Output	Open drain secondary throttle signal
37	Output	Secondary throttle signal
38	Output	Secondary throttle (COM)
39	Relay Contact	Secondary throttle increment (N/O)
40	Relay Contact	Secondary throttle increment (COM)
41	Relay Contact	Secondary throttle decrement (N/O)
42	Relay Contact	Secondary throttle decrement (COM)
Separate earth stud		

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	310 x 155 x 250. For Mounting hole detail Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	5.2
Mounting method	Bulkhead mounting, external feet 4 x M6 bolts
Enclosure material	Aluminium die-cast: G AI SI 12 / DIN 1725, Leg. 230
Surface finish	Structure paint + baked enamel finish, stone grey RAL 7032. Polyester overlay on front cover.
Enclosure gasket	Neoprene, oil and petrol resistant (-30deg C to 100 deg C)
Maintenance	Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environment

Ambient temperature	+5 to +55 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 44

Power and Interlock Module

General

Module Name	Power and Interlock Module
Part Number	CTITF04002
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Power and Interlock Module is where the ships power is connected to MECS. The PIM provides: ▪ A connection point for raw primary and secondary electric power for the jet. ▪ A filtered primary and secondary power for MECS ▪ An engine start interlock where there is no ECM. ▪ A system alarm relay ▪ External power for auxiliary use.
User Controls	None
Display	None
Performance	
Data Rates	Not applicable
Time to operation from power up	Less than 2s
Control Accuracy	Not applicable
Calibration	Not applicable

Electrical

Operating voltage	24V Nominal. Variation -25% to +30%
Power consumption	Typically less than 0.1A
Electrical Protection	Over voltage protection provided. Chassis connected to cable shields.
Connections	Two 12 way two-part bayonet type connectors and 5 cable glands for user connection. Wiring is to be according to the system wiring diagram. Connector is: - Name Description JCM Jet Control Module connection Connector identification: Polycarbonate label on lower edge of front cover.

Internal Terminal User Connections:		
Terminal Number	I/O	Description
1	Input	+24V primary power supply
2	Input	0V primary power supply
3	Input	+24V secondary power supply

4	Input	0V secondary power supply
5	Input	Positive gearbox 'in gear' feedback
6	Input	Negative gearbox 'in gear' feedback
7	Relay contact	Alarm relay contact (COM)
8	Relay contact	Alarm relay contact (NO)
9	Relay contact	Alarm relay contact (NC)
10	Relay contact	Engine start relay contact (COM)
11	Relay contact	Engine start relay contact (NO)
12	Relay contact	Engine start relay contact (NC)
13	Input	+24V engine power supply
14	Input	0V engine power supply
15	Output	+24V MECS aux power output
16	Output	0V MECS aux power output
Separate earth stud		

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	215 x 105 x 155. For Mounting hole detail Refer Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	2.5
Mounting method	Bulkhead mounting, external feet 4 x M6 bolts
Enclosure material	Aluminium die-cast: G Al Si 12 / DIN 1725, Leg. 230
Surface finish	Structure paint + baked enamel finish, stone grey RAL 7032. Polyester overlay on front cover.
Enclosure gasket	Neoprene, oil and petrol resistant (-30deg C to 100 deg C)
Maintenance	Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environment

Ambient temperature	+5 to +55 deg C		
Ambient humidity	Relative humidity up to 100% at all relevant temperatures		
Vibration	**Frequency**	**Amplitude**	**Acceleration**
	3 – 13.2 Hz	1.0 mm peak	
	13.2 – 100 Hz		0.7 g
EMC	**Test Type**	**Test Basis**	
	Electrostatic discharge	IEC 61000-4-2	
	Radiated susceptibility	IEC 61000-4-3	
	Conducted low frequency	IEC 60945	
	Conducted radio frequency	IEC 61000-4-6	
	Burst/fast transients	IEC 61000-4-4	
	Surge/slow transient	IEC 61000-4-5	
	Radiated emissions	EN 50081-2	
	Conducted emissions	EN 50081-2	
Degree of protection	IP 44		

Jet Junction Box

General

Module Name	Jet Junction Box
Part Number	CTITF03004
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Jet Junction Box (JJB) is the termination point on the jet for the sensors and solenoid drive cables. It is usually supplied mounted on the jet.
User Controls	None
Display	None

Performance

Data Rates	CAN network communications data rate: Not applicable RS485 network communications data rate: 9600 bps
Time to operation from power up	Less than 2s
Control Accuracy	Not applicable
Calibration	Module is recalibrated via software setup during vessel commissioning.

Electrical

Operating voltage	24V Nominal. Variation -25% to +30%
Power consumption	Typically less than 0.05A
Electrical Protection	Over voltage protection provided on inputs. Internal fuses are all solid state and reset automatically on module power-down.
Connections	Two 12 way two-part bayonet type connectors. Connectors are: - Name Description Fb Feedback connection to Jet Control Module Dv Drive connection to Jet Control Module Connector identification: Polycarbonate label on lower edge of front cover. Separate earth stud.

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	160 x 100 x 175 (Excluding conduit fittings and mounting bracket)
Weight (kg)	2.5
Mounting method	Attached to the jet with anti vibration mounts
Enclosure material	Aluminium die-cast: G AI SI 12 / DIN 1725, Leg. 230
Surface finish	Structure paint + baked enamel finish, stone grey RAL 7032. Polyester overlay on front cover.
Enclosure gasket	Neoprene, oil and petrol resistant (-30deg C to 100 deg C)
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environment

Ambient temperature	+5 to +55 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 44

Helm Module

General

Module Name	Helm Module
Part Number	CTHLM08006
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Helm Module is an optional steering module. A number of wheel options are available. Inside a ganged potentiometer connected to the main shaft provides an electrical signal corresponding to the helm wheel displacement. One potentiometer gives signals to the port Control Panel Module (CPM) at that station and the other gives a signal to the starboard CPM. There is an illuminated pushbutton switch to allow control to be moved to this station.
User Controls	1 x pushbutton switch. An illuminated pushbutton switch allows control to be transferred to this helm. 1 x control shaft. This is used for steering the vessel.
Display	None

Performance

Data Rates	Not applicable
Time to operation from power up	Not applicable
Control Accuracy	Potentiometer output
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	5V
Power consumption	5mA per potentiometer
Electrical Protection	Chassis connected to cable shields.
Connections	Two 12 way two-part bayonet type connectors. Connectors are: - Name — Description Port — Connection to port Control Panel Module Starboard — Connection to starboard Control Panel Module Connector identification label next to connectors Separate earth stud.

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	180 x 125 x 180. For Mounting hole detail Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	3.7 (wheel not included)
Mounting method	Bulkhead mounting, 4 x M6 bolts
Enclosure material	Front assembly: machined aluminium alloy Shaft: 316 stainless steel Rear cover: fabricated 316 stainless steel sheet
Surface finish	Front assembly: powder coated black Rear cover: polished
Enclosure gasket	EDPM foam gasket seals rear cover to front assembly and front assembly to console.
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	-25 to +70 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 56 when sealed to control console.

Dual Lever SLC Module

General

Module Name	Dual Lever SLC Module
Part Number	CTCLV04008
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Dual Lever SLC can be used either as a reverse lever, throttle lever or as a combined single lever control head. There is a removable detent to indicate the zero speed position. In quad jet installations one Dual Lever SLC may control all four engines and jets.
User Controls	2 x control levers
Display	None

Performance

Data Rates	Not applicable
Time to operation from power up	Not applicable
Control Accuracy	Potentiometer output
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	5V
Power consumption	5mA per potentiometer
Electrical Protection	Chassis connected to cable shield.
Connections	Two 12 way two-part bayonet type connectors. Connectors are: - Name — Description Port — Connection to port Control Panel Module Starboard — Connection to starboard Control Panel Module Connector identification label next to connectors Separate earth stud.

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	145 x 235 x 150. For Mounting hole detail Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	4.0
Mounting method	Console mounting, 4 x M6 bolts
Enclosure material	Front assembly: injection moulded plastic Rear cover: fabricated 316 stainless steel sheet
Surface finish	Front assembly: as cast Rear cover: polished
Enclosure gasket	EDPM foam gasket seals rear cover to front assembly.
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	-25 to +70 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 56 when sealed to control console. For deck mounted control panels it is recommended that a sealed hard cover is always fitted over the panels when not in use.

Hand Held Remote Control

General

Module Name	Hand Held Remote
Part Number	CTCPL14004
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Hand Held Remote is a self contained unit for controlling the vessel up to 10m from a control station. The Hand Held Remote requires a Hand Held Remote Junction Box to connect to the MECS.
User Controls	2 x control levers for engine and reverse duct control. 1 x knob for steering 1 x illuminated pushbutton switch for control transfer 1 x safety switch to warn if the user becomes separated from the HHR unit.
Display	None

Performance

Data Rates	Not applicable
Time to operation from power up	Not applicable
Control Accuracy	Potentiometer output
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	5V
Power consumption	5mA per potentiometer
Electrical Protection	Chassis connected to cable shield.
Connections	One cable with 19 way connector attached for connection to HHR junction box.

Mechanical

Dimensions Overall (±5mm) W x D x H (mm)	125 x 105 x 220 (excluding cable)
Weight (kg)	2.4 (with cable)
Mounting method	Not applicable
Enclosure material	Aluminium die-cast:
Surface finish	Powder coated black
Enclosure gasket	EDPM foam gasket seals rear cover to main assembly.
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that controls and cable and connector is secure.

Environmental

Ambient temperature	+5 to +55 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	**Frequency** / **Amplitude** / **Acceleration** 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	**Test Type** / **Test Basis** Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 44

Hand Held Remote Junction Box

General

Module Name	Hand Held Remote Junction Box
Part Number	CTITF04004
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Hand Held Remote Junction Box is the interface that is used to connect the Hand Held Remote to the MECS.
User Controls	None
Display	None

Performance

Data Rates	Not applicable
Time to operation from power up	Not applicable
Control Accuracy	Not applicable
Calibration	No calibration is required

Electrical

Operating voltage	Not applicable
Power consumption	Not applicable
Electrical Protection	Chassis connected to cable shield.
Connections	Two 12 way two-part bayonet type connectors on cables. One 19 way connector for connection to the HHR. Separate earth stud.

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	215 x 105 x 150. For Mounting hole detail Refer Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	3.4
Mounting method	Bulkhead mounting, external feet 4 x M6 bolts
Enclosure material	Aluminium die-cast: G Al Si 12 / DIN 1725, Leg. 230
Surface finish	Structure paint + baked enamel finish, stone grey RAL 7032. Polyester overlay on front cover.
Enclosure gasket	Neoprene, oil and petrol resistant (-30deg C to 100 deg C)
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	+5 to +55 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	**Frequency** / **Amplitude** / **Acceleration** 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	**Test Type** / **Test Basis** Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 44

Autopilot Interface Module

General

Module Name	Autopilot Interface Module
Part Number	CTITF01003
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Autopilot Interface Module (API) enables third party autopilot controls to be connected to MECS. The API requires a 'Steering Demand' and an 'Autopilot in Command' signal and provides a 'Steering Feedback Signal'.
User Controls	None
Display	None

Performance

Data Rates	Control update rate: 25 Hz Network communications data rate: 41.666 KBaud Maximum network message rate: > 8Hz Minimum network message rate: 1Hz
Time to operation from power up	Less than 2s
Control Accuracy	Input to output better than 1% linearity
Calibration	Calibration is not required

Electrical

Operating voltage	24V Nominal. Variation -25% to +30%. Supplied from the Control Panel Module
Power consumption	Typically less than 0.20A
Electrical Protection	Over voltage protection provided. Internal fuses are all solid state and reset automatically on module power-down. Optically isolated inputs
Connections	Two 12 way two-part bayonet type connectors and one cable gland for user connections. Connectors are: - Name — Description Pn — To CPM Nx connector Nx — CAN Bus extension Connector identification: Polycarbonate label on lower edge of front cover.

Internal Terminal User Connections:		
Terminal Number	I/O	Description
1	Relay contact	Autopilot enable relay (N/O)
2	Ground	Aux power ground
3	Input	'Autopilot On' signal from autopilot
4	Input	'Autopilot Alarm' signal from autopilot
5	Input	Autopilot 'Port Demand' signal
6	Input	Autopilot 'Starboard Demand' signal
7	Output	Autopilot 'Steering F/B' signal
8	Output	Autopilot 'F/B Reference' signal
9	Input	Autopilot 'Steering Demand' signal
10	Relay contact	Autopilot enable relay (COM)
11	Relay contact	Autopilot enable relay (N/C)
12	I/O	RS485+
13	I/O	RS485-
14	Ground	
Separate earth stud		

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	195 x 105 x 190. For Mounting hole detail Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	2.5
Mounting method	Bulkhead mounting, external feet 4 x M6 bolts
Enclosure material	Aluminium die-cast: G AI SI 12 / DIN 1725, Leg. 230
Surface finish	Structure paint + baked enamel finish, stone grey RAL 7032. Polyester overlay on front cover.
Enclosure gasket	Neoprene, oil and petrol resistant (-30deg C to 100 deg C)
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	+5 to +55 deg C		
Ambient humidity	Relative humidity up to 100% at all relevant temperatures		
Vibration	Frequency	Amplitude	Acceleration
	3 – 13.2 Hz	1.0 mm peak	
	13.2 – 100 Hz		0.7 g
EMC	Test Type	Test Basis	
	Electrostatic discharge	IEC 61000-4-2	
	Radiated susceptibility	IEC 61000-4-3	
	Conducted low frequency	IEC 60945	
	Conducted radio frequency	IEC 61000-4-6	
	Burst/fast transients	IEC 61000-4-4	
	Surge/slow transient	IEC 61000-4-5	
	Radiated emissions	EN 50081-2	
	Conducted emissions	EN 50081-2	
Degree of protection	IP 44		

Joystick Helm Module

General

Module Name	Joystick Helm Module
Part Number	CTHLM05003
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Joystick Helm Module is an optional steering module. Inside a ganged potentiometer connected to the joystick shaft provides an electrical signal corresponding to the joystick displacement. One potentiometer gives signals to the port Control Panel Module (CPM) at that station and the other gives a signal to the starboard CPM. There is an illuminated pushbutton switch to allow control to be moved to this station.
User Controls	1 x pushbutton switch. An illuminated pushbutton switch allows control to be transferred to this station. 1 x joystick lever. This is used for steering the vessel.
Display	None

Performance

Data Rates	Not applicable
Time to operation from power up	Not applicable
Control Accuracy	Potentiometer output
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	5V
Power consumption	5mA per potentiometer
Electrical Protection	Chassis connected to cable shield.
Connections	Two 12 way two-part bayonet type connectors. Connectors are: - Name — Description Port — Connection to port Control Panel Module Starboard — Connection to starboard Control Panel Module Connector identification label next to connectors Separate earth stud.

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	115 x 210 x 150. For Mounting hole detail Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	1.6
Mounting method	Console mounting vertical or horizontal 2 x M6 screws.
Enclosure material	Front plate: machined 5083 aluminium plate Rear cover: fabricated 316 stainless steel sheet
Surface finish	Front plate: powder coated black Rear cover: polished Handle: 10mm dia stainless steel shaft. Plastic ball or cylindrical handle depending on the option.
Enclosure gasket	EDPM foam gasket seals rear cover to front plate and front plate to console.
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	-25 to +70 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge — IEC 61000-4-2 Radiated susceptibility — IEC 61000-4-3 Conducted low frequency — IEC 60945 Conducted radio frequency — IEC 61000-4-6 Burst/fast transients — IEC 61000-4-4 Surge/slow transient — IEC 61000-4-5 Radiated emissions — EN 50081-2 Conducted emissions — EN 50081-2
Degree of protection	IP 56 when sealed to control console. For deck mounted modules it is recommended that a sealed hard cover is always fitted over the panels when not in use.

Manoeuvring Joystick Module

General

Module Name	Manoeuvring Joystick Module
Part Number	CTCLV07004 CTCLV07005
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Maneuvering Joystick Module (MJM) is an optional steering module. Inside a Hall Effect 3-axis joystick provides electrical signals corresponding to the joystick displacement to the CPM. There is an illuminated pushbutton switch to allow control to be moved to this station.
User Controls	1 x pushbutton switch. An illuminated pushbutton switch allows control to be transferred to this station. 1 x joystick lever. This is used for steering the vessel.
Display	None

Performance

Data Rates	Not applicable
Time to operation from power up	Not applicable
Control Accuracy	Hall Effect output
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	5V
Power consumption	10mA per axis
Electrical Protection	Chassis connected to cable shield.
Connections	Two 12 way two-part bayonet type connectors. Connectors are: - Name — Description Port — Connection to port Control Panel Module Starboard — Connection to starboard Control Panel Module Connector identification label next to connectors Separate earth stud.

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Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	150H x 115W x 177D. For Mounting hole detail Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	1.2
Mounting method	Console mounting vertical or horizontal 2 x M6 screws.
Enclosure material	Front plate: machined 5083 aluminium plate Rear cover: fabricated 316 stainless steel sheet
Surface finish	Front plate: powder coated black Rear cover: polished Handle: 10mm dia stainless steel shaft. Plastic ball or cylindrical handle depending on the option.
Enclosure gasket	EDPM foam gasket seals rear cover to front plate and front plate to console.
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	-25 to +70 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 56 when sealed to control console. For deck mounted modules it is recommended that a sealed hard cover is always fitted over the panels when not in use.

Dynamic Positioning Interface Module

General

Module Name	Dynamic Positioning Interface
Part Number	CTITF01005
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Dynamic Positioning Interface (DPI) is a module that allows MECS to interface easily with a number of proprietary Dynamic Positioning Systems. It provides two isolated DP interface channels. Each module is mounted on the bridge and is connected between a control panel and the Dynamic Positioning System. One DPI is required for each jet. It performs the following functions: ▪ Receives azimuth and thrust commands in the form of analogue voltages from the DP system ▪ Converts the azimuth and thrust commands to waterjet steering, reverse and engine RPM demands and transmits these over the MECS CAN bus. ▪ Receives MECS steering, reverse and RPM feedback messages from the CAN bus and converts these to azimuth and thrust feedback. ▪ Sends the azimuth and thrust feedback to the DP system in the form of analogue voltages.
User Controls	None
Display	None

Performance

Data Rates	Local loop update rate: 25 Hz Network communications data rate: 41.666 KBaud Maximum network message rate: > 8Hz Minimum network message rate: 1Hz
Time to operation from power up	Less than 2s
Resolution	12 bit A-D and D-A conversion on DPS interfaces
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	24V Nominal. Variation -25% to +30%
Power consumption	Less than 0.2A
Electrical Protection	Over voltage and reverse polarity protection provided. Internal fuse is solid state and resets automatically on module power-down. Optically isolated inputs and outputs to DPS.

Connections	Electrical connections to MECS are via a 12 way two-part bayonet type connector. Connections to the DP system are via two 23-way connectors (channel A and channel B). Mating plug and cable assemblies are supplied to interface between the DPI module and the DP system. These cables are unterminated at the DP system end for connection to screw terminals. The pin allocation is as follows: -

Function	Signal Type	Dir'n	Connector/Pin
Azimuth demand (channel A) Analogue ground	Analogue -/+ 10V	Input	DP1-20 DP1-21
Thrust demand (channel A) Analogue ground	Analogue 0 – 10V	Input	DP1-22 DP1-23
Azimuth feedback (channel A) Analogue ground	Analogue -/+ 10V	Output	DP1-17 DP1-16
Thrust feedback (channel A) Analogue ground	Analogue 0 – 10V	Output	DP1-19 DP1-18
'Ready' signal (channel A)	Relay	Output	DP1-10 DP1-2
'DP_Enabled' signal (channel A) Digital ground	Digital	Input	DP1-14 DP1-7
Azimuth demand (channel B) Analogue ground	Analogue -/+ 10V	Input	DP2-20 DP2-21
Thrust demand (channel B) Analogue ground	Analogue 0 - 10V	Input	DP2-22 DP2-23
Azimuth feedback (channel B) Analogue ground	Analogue -/+ 10V	Output	DP2-17 DP2-16
Thrust feedback (channel B) Analogue ground	Analogue 0 - 10V	Output	DP2-19 DP2-18
'Ready' signal (channel B)	Relay	Output	DP2-10 DP2-2
'DP_Enabled' signal (channel B) Digital ground	Digital	Input	DP2-14 DP2-7

Connector identification: Polycarbonate label on lower edge of front cover.

Separate earth stud.

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	275 x 105 x 190 For Mounting hole detail Refer Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	2.8
Mounting method	Bulkhead mounting, external feet 4 x M6 bolts
Enclosure material	Aluminium die-cast: G Al Si 12 / DIN 1725, Leg. 230
Surface finish	Structure paint + baked enamel finish, stone grey RAL 7032.
Enclosure gasket	Neoprene, oil and petrol resistant (-30deg C to 100 deg C)
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	+5 to +55 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 44

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Tiller Helm Module

General

Module Name	Tiller Helm Module
Part Number	CTHLM05005
Identification	Stamped aluminium identification plate containing: - ▪ Module Part Number ▪ Serial Number ▪ Module Revision
Description	The Tiller Helm Module is an optional steering module. Various steering direction options and handle styles are available. Inside a ganged potentiometer connected to the main shaft provides an electrical signal corresponding to the tiller handle displacement. One potentiometer gives signals to the port Control Panel Module (CPM) at that station and the other gives a signal to the starboard CPM. There is an illuminated pushbutton switch to allow control to be moved to this station.
User Controls	1 x pushbutton switch. An illuminated pushbutton switch allows control to be transferred to this station. 1 x control lever. This is used for steering the vessel.
Display	None

Performance

Data Rates	Not applicable
Time to operation from power up	Not applicable
Control Accuracy	Potentiometer output
Calibration	Module is calibrated via software set up during vessel commissioning.

Electrical

Operating voltage	5V
Power consumption	5mA per potentiometer
Electrical Protection	Chassis connected to cable shield.
Connections	No user connections inside. External connectors are two 12 way two-part bayonet type connectors. Name — Description Port — Connection to port Control Panel Module Starboard — Connection to starboard Control Panel Module Note: Connector identification label next to connectors Separate earth stud.

Mechanical

Dimensions overall (± 5mm) W x D x H (mm)	115 x 140 x 140 (excluding lever) For Mounting hole detail Refer: Drawing "MECS Module Dimensions" on Page 10-33
Weight (kg)	1.7
Mounting method	Console mounting vertical or horizontal 2 x M6 screws.
Enclosure material	Front plate: machined 5083 aluminium plate Rear cover: fabricated 316 stainless steel sheet
Surface finish	Front plate: powder coated black Rear cover: polished Handle: 10mm dia stainless steel shaft. Plastic ball or cylindrical handle depending on the option.
Enclosure gasket	EDPM foam gasket seals rear cover to front plate and front plate to console.
Maintenance	No internal access to module required. Keep outside of module clean, dry and free of oil and salt contamination. Periodically check that mounting bolts, external connectors and cables are secure.

Environmental

Ambient temperature	-25 to +70 deg C
Ambient humidity	Relative humidity up to 100% at all relevant temperatures
Vibration	Frequency / Amplitude / Acceleration 3 – 13.2 Hz / 1.0 mm peak 13.2 – 100 Hz / 0.7 g
EMC	Test Type / Test Basis Electrostatic discharge / IEC 61000-4-2 Radiated susceptibility / IEC 61000-4-3 Conducted low frequency / IEC 60945 Conducted radio frequency / IEC 61000-4-6 Burst/fast transients / IEC 61000-4-4 Surge/slow transient / IEC 61000-4-5 Radiated emissions / EN 50081-2 Conducted emissions / EN 50081-2
Degree of protection	IP 56 when sealed to control console. For deck mounted control panels it is recommended that a sealed hard cover is always fitted over the panels when not in use.

Voyage Data Recorder Interface

Functional Description

The Voyage Data Recorder Interface collects data from all connected MECS control Can buses then translates the data into RS485 serial sentences for controlled transmission to third party monitoring or recording equipment. See document 086219 Waterjet Controls NMEA 0183 Binding.

Two channels of “talk only” RS485 two wire data are provided via Phoenix Contact three way plugs 2 off MSTB2,5/3-ST (supplied with the module).

NMEA0 transmits data from all connected water jets when single port binding (1Prt) is selected.

Triple jet or higher installations require more than one channel to report on all jets (except if 1 Prt binding is used).

The VDRI includes a real time clock module used to time stamp data and to provide data for time sentences. For further information see document 086219 Waterjet Controls NMEA 0183 Binding.

Power Supply

The power required for the VDI module is provided by the MECS Control Panel Module connected to Nx Jet1 and Nx Jet4. The two power sources are monitored and the power source selected by the VDRI module. The default source is Nx Jet1.

Data Output Connections (RS4850

Data Name	Label	Signal Type	Connector Pin
NMEA0	A	Transmit A	1
	B	Transmit B	2
	G	ground	3

NMEA1	A	Transmit A	5
	B	Transmit B	6
	G	ground	7
		n/c	9
		n/c	10
		n/c	11
		n/c	12

Port Settings (Output)

The listed baud rates can be set during setup of the MECS VDI.

The default setting is “high”.

- Baud rates: std (9600), high (38400), 56000, 115000
- Format: Data bits = 8,
- Parity = none,
- Stop bits = 1,
- Flow control = none

Rate (Package Rate)

The power required for the VDI module is provided by the MECS Control Panel Module connected to Nx Jet1 and Nx Jet4. The two power sources are monitored and the power source selected by the VDRI module. The default source is Nx Jet1.

Output Data Mapping

The following table describes the mapping of jet number and the data channels.

	NMEA0 RS485 Output Port / Starboard	NMEA1 RS485 Output Port / Starboard	Channel 3 Port / Stbd
Single	Jet 1 (port)		
Twin	Jet 1 (port)/ Jet 2 (stbd)		
Triple	Jet 1 (port) / Jet 3 (stbd)	Jet 2 (centre)	
Quad	Jet 1 (port outer)/ Jet 4 (stbd outer)	Jet 2 (port inner)/ Jet 3 (stbd inner)	
Quin	Jet 1 (port outer)/ Jet 5 (stbd outer)	Jet 2 (port inner)/ Jet 4 (stbd inner)	Jet 3 (centre)

Jet numbering in the above table is Hamilton format i.e. port outer jet is number 1 and the jet number increases to starboard. If data is required from more than four Jets a second VDI module will be required.

MECS based non-VDR systems with a limited number of channels may consider using just NMEA0, binding set to “1Prt” (see 086219 Waterjet Controls NMEA 0183 Binding - Single Port Binding section 10).

10

MECS Bus Connections

Four ITT Canon 12 way circular connectors labelled Nx(L) Jet1 to 4 are provided for connection to the Nx port on MECS Control Panels at the last control station on the control bus. Galvanic isolation between control buses is maintained.
These bus inputs are to be connected as listed table below:

VDI connector	Nx Jet1	Nx Jet2	Nx Jet3	Nx Jet4
Single	CPM 1 Nx			
Twin	CPM 1 Nx			CPM 2 Nx
Triple	CPM 1 Nx	CPM 2 Nx		CPM 3 Nx
Quad	CPM 1 Nx	CPM 2 Nx	CPM 3 Nx	CPM 4 Nx

CPM = MECS Control Panel Module. Nx = port connection on that control panel.

The four connectors labelled Pn(L) Jet 1 to 4 are provided to enable the extension of the control bus to other MECS modules i.e. API and DPI modules.

MECS Can Bus Terminations

Bus termination jumpers a provided for each of the four buses input if required.

Real Time Clocks

The real time clock is set via the VDI setup menu.

- Menu settings: hours, minutes.

Identifier

Identifiers are set in the VDI setup menu.

Identifiers available:

- SG
- RC
- P
- PCWF

Profiles

This section lists the sentences available with each profile provided by the Voyage data interface module. For further information on the sentence structure etc. see the 086219 Waterjet Controls NMEA 0183 Binging document.

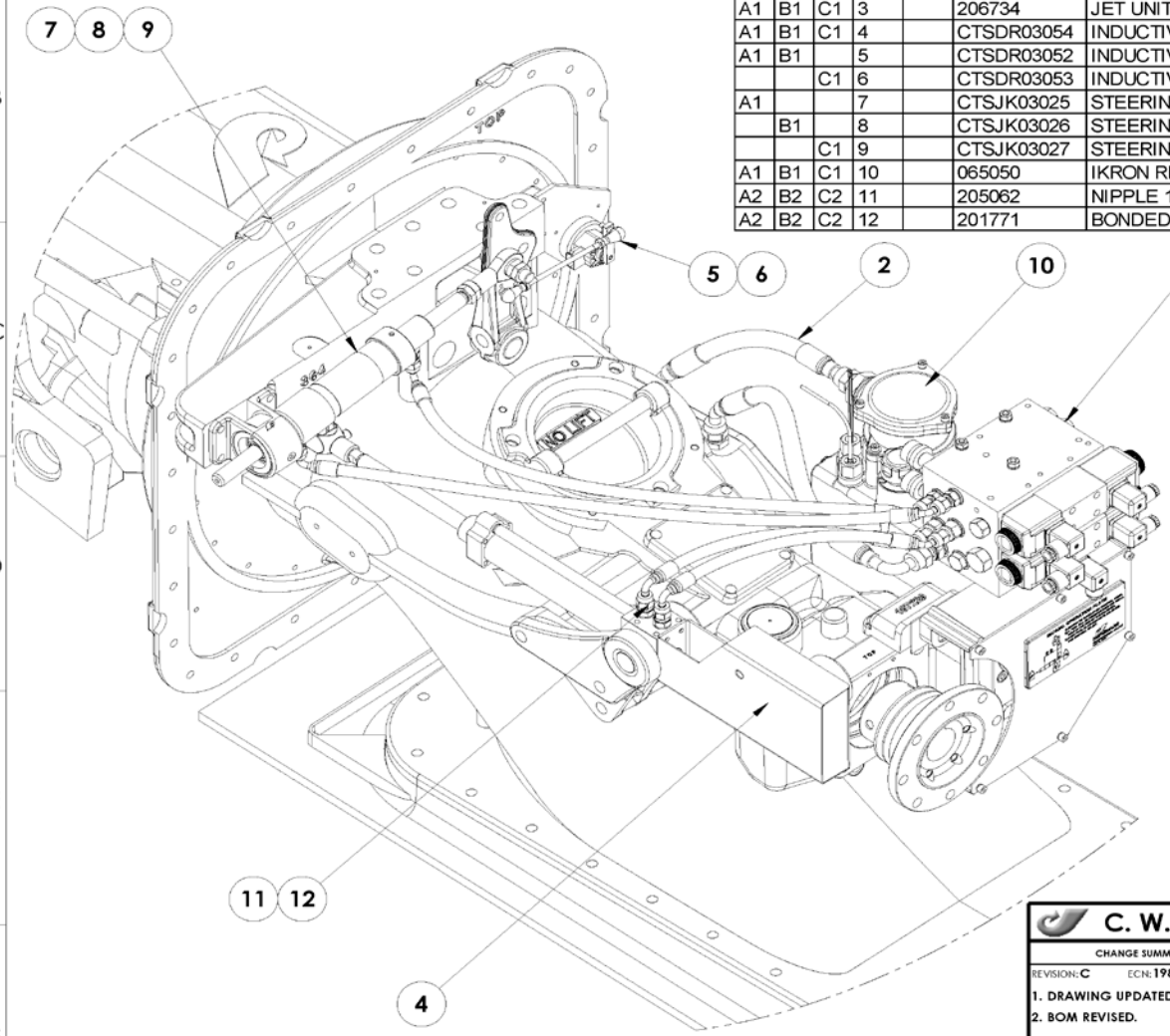
- NMEA sentence: ALR, RPM, RSA, ZDA
- XDR sentence: ALR, RPM, RSA, XDR, ZDA
- CWFH sentence: ALR, PRC, RPM, RRC, RSA, SYS, XDR(bearing), XDR (JHPU), ZDA
- 1Prt sentence: ALR, PRC, RPM, RRC, RSX, XDR(bearing), XDR(JHPU), SYS, ZDA
- ALM Sentence: ALR.
- d102 Sentence: ALR, PRC, RPM, RSA, ZDA
- Broadgate Sentence: ALR, AA, BA, CA, GA, HA

11 - Technical Drawings

In This Section

11

A	B	C	Item	Kit	Part Number	Product Description	Drawing
				A	CT36408001	JET SPECIFIC "MECS" 1 JET NO ROTATION	CT36408001
				B	CT36408002	JET SPECIFIC "MECS" 1 JET PORT ROTATION	CT36408001
				C	CT36408003	JET SPECIFIC "MECS" 1 JET STARBOARD ROTATION	CT36408001
A1	B1	C1	1		CTHPU27003	JHPU PROPORTIONAL FULL FILTRATION (STD) - 364 MECS	CTHPU21000
A1	B1	C1	2		CTHSE12076	MECS HOSE KIT (FULL FILTRATION) 364	CTHSE12076
A1	B1	C1	3		206734	JET UNIT JUNCTION BOX 364 JET MECS (REMOTE MOUNTED)	CTITF03004
A1	B1	C1	4		CTSDR03054	INDUCTIVE SENDER REVERSE (HALL ANGLE)	CTSDR03054
A1	B1		5		CTSDR03052	INDUCTIVE SENDER STEERING NON ROTATED & PORT ROTATION (HALL ANGLE) 364	CTSDR03052
		C1	6		CTSDR03053	INDUCTIVE SENDER STEERING STARBOARD ROTATED (HALL ANGLE) 364	CTSDR03052
A1			7		CTSJK03025	STEERING CYLINDER PWR HELM CENTRE	CTSJK 03025
	B1		8		CTSJK03026	STEERING CYLINDER PWR HELM ROTATED PORT (HAMILTON CYLINDER) HJ364	CTSJK 03025
		C1	9		CTSJK03027	STEERING CYLINDER PWR HELM ROTATED STBD (HAMILTON CYLINDER) HJ364	CTSJK 03025
A1	B1	C1	10		065050	IKRON RETURN LINE FILTER ELEMENT (HHC03577)	CTHPU10002
A2	B2	C2	11		205062	NIPPLE 1/4" BSPP MALE x 1/4" BSPP MALE # Z101004	115000
A2	B2	C2	12		201771	BONDED SEAL 1-1/4" BSP (400-832-4490-74)	N/A



364 JET WITH NON ROTATED STEERING SHOWN
CT364 08 001

C. W. F. Hamilton & Co. Ltd

CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS

REVISION: C ECN: 19832

1. DRAWING UPDATED PICTORIALLY
2. BOM REVISED.

MANUFACTURING INFORMATION

MATERIAL: N/A

STANDARD:

MAT CERT REQ: No TRACEABILITY REQ: No

FINISHED WEIGHT: [kg]

DRAWING INFORMATION

JET SPECIFIC CONTROLS
for MECS
HJ364

DESIGN CHECK:	A.A	2/07/2012	SIGN.
DRAWING REVISION:	J.S.R.	2/07/2012	SIGN.
DOCUMENT CHECK:	S.K.	2/07/2012	SIGN.
ORIGINAL DESIGN:	P.M.W	9/08/2007	SIGN.

ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED

REMOVE ALL SHARP EDGES & BURRS

UNTOLERANCED DIMENSIONS & SURFACE FINISH
GENERAL: +/- HOLES: ∅ ANGULAR: °
MACHINED SURFACE FINISH: Ra µm

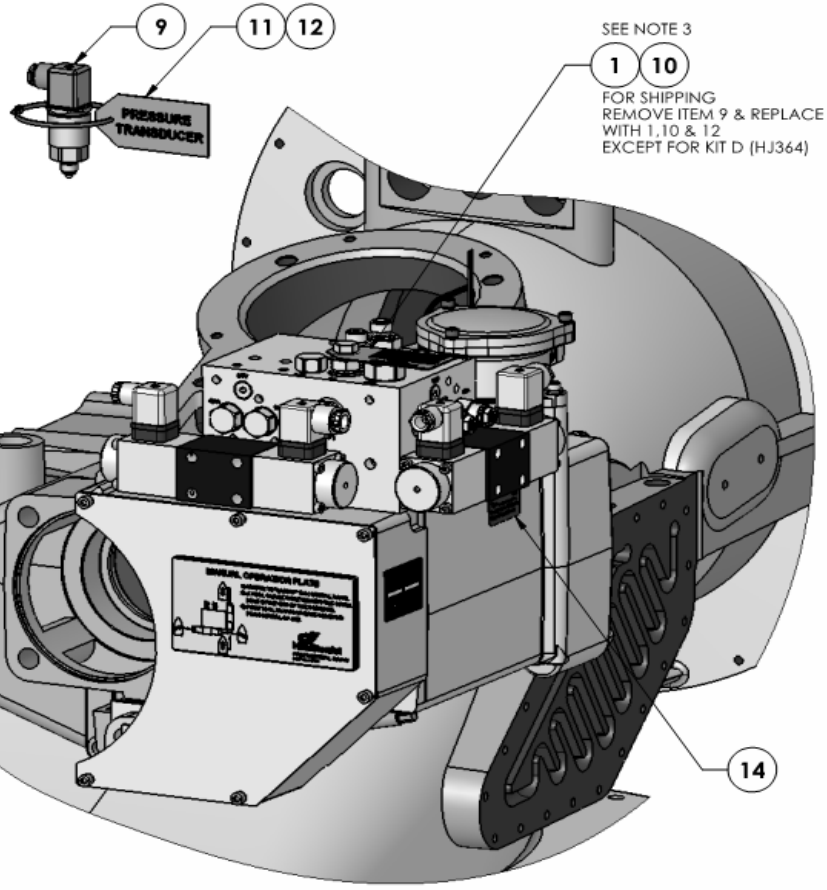
JET / CONTROL TYPE: HM364

DRAWN TO HAMJET 085195 PROJECTION:

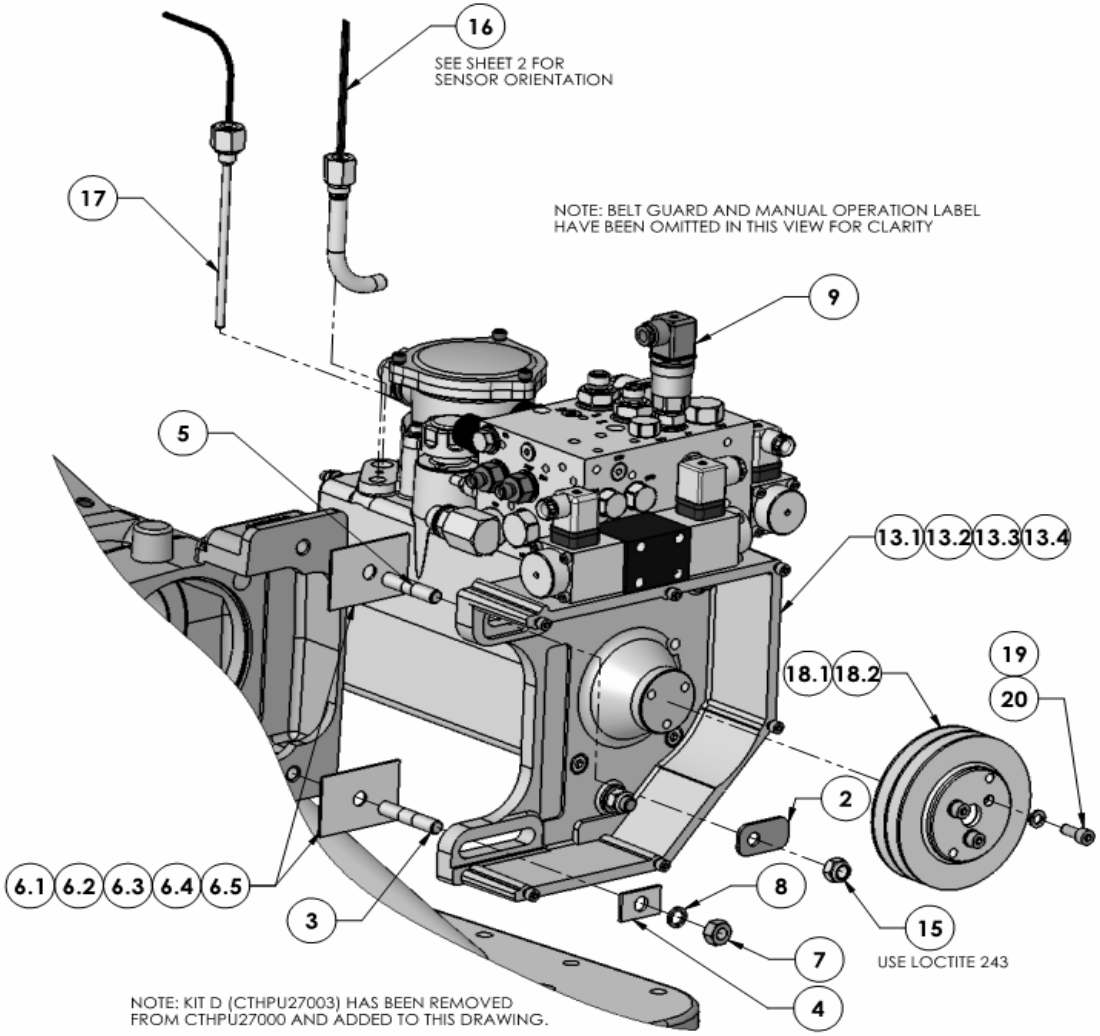
SCALE: 1:6 SHEET SIZE A3 Sheet1/1

DWG No: CT364 08000 REV: C

NOTES:
1. REFER TO DRAWING 85139 SHEET 2 FOR PAINTING OF JHPU ASSEMBLY
2. REFER TO DRAWING 111178 FOR PAINT SPECIFICATION AND APPLICATION
3. PRIOR TO COMMISSIONING REMOVE PLUG (ITEM 1) & LABEL (ITEM 10) AND INSTALL PRESSURE TRANSDUCER ASSEMBLY (ITEM 9)



SHIPPING CONFIGURATION



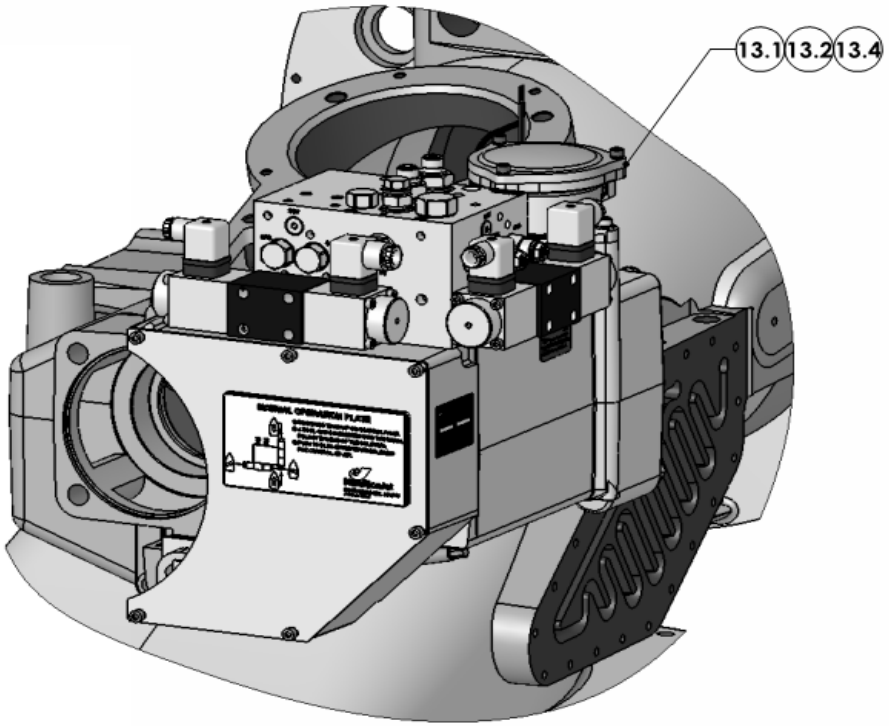
NOTE: KIT D (CTHPU27003) HAS BEEN REMOVED
FROM CTHPU27000 AND ADDED TO THIS DRAWING.

C. W. F. Hamilton & Co. Ltd

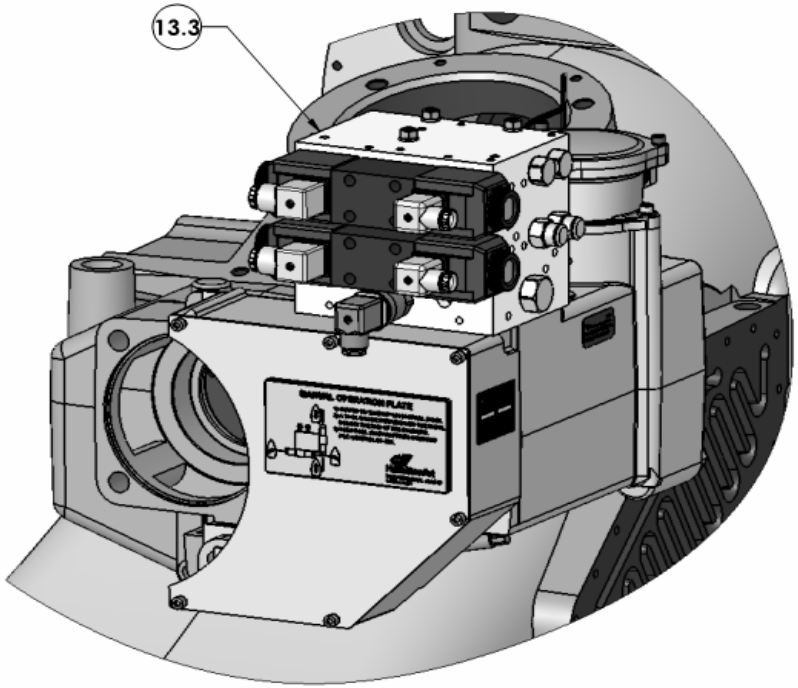
CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS			
REVISION: AG	ECN: 19845		
SHEET 2 ADDED TO SHOW KIT D			
DESIGN CHECK:	A.A	2/07/2012	SIGN.:
DRAWING REVISION:	J.S.R.	2/07/2012	SIGN.:
DOCUMENT CHECK:	S.K.	2/07/2012	SIGN.:
ORIGINAL DESIGN:	I.B.W	9/10/1997	SIGN.:

MANUFACTURING INFORMATION
MATERIAL: N/A
STANDARD:
MAT CERT REQ: No TRACEABILITY REQ: No
FINISHED WEIGHT: [kg]
ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED
REMOVE ALL SHARP EDGES & BURRS
UNTOLERANCED DIMENSIONS & SURFACE FINISH
GENERAL: +/- HOLES: Ø ANGULAR: °
MACHINED SURFACE FINISH: Ra µm

DRAWING INFORMATION			
JET HYDRAULIC POWER UNIT REVERSE AND STEERING SYSTEM (MECS)			
JET / CONTROL TYPE: 362-571			
DRAWN TO HAMJET 085195	PROJECTION:		
SCALE: 1:4	SHEET SIZE A3	Sheet1/3	
DWG No: CTHPU21000	REV: AG		



KITS A,B,C AND E



KIT D

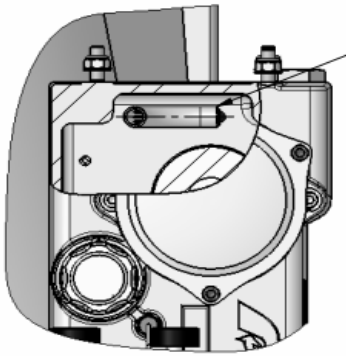
C. W. F. Hamilton & Co. Ltd

CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS			
REVISION: AG ECN: 19845			
SHEET 2 ADDED TO SHOW KIT D			
DESIGN CHECK:	A.A	2/07/2012	SIGN:
DRAWING REVISION:	J.S.R.	2/07/2012	SIGN:
DOCUMENT CHECK:	S.K.	2/07/2012	SIGN:
ORIGINAL DESIGN:	I.B.W	9/10/1997	SIGN:

MANUFACTURING INFORMATION
MATERIAL: N/A
STANDARD:
MAT CERT REQ: No TRACEABILITY REQ: No
FINISHED WEIGHT: [kg]
ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED
REMOVE ALL SHARP EDGES & BURRS
UNTOLERANCED DIMENSIONS & SURFACE FINISH
GENERAL: +/- HOLES: Ø ANGULAR: °
MACHINED SURFACE FINISH: Ra µm

DRAWING INFORMATION			
JET HYDRAULIC POWER UNIT REVERSE AND STEERING SYSTEM (MECS)			
JET / CONTROL TYPE: 362-571			
DRAWN TO HAMJET 085195	PROJECTION:		
SCALE: 1:4	SHEET SIZE A3	Sheet2/3	
DWG No: CTHPU21000	REV: AG		

A	B	C	D	E	Item	Kit	Part Number	Product Description	Drawing
						A	CTHPU21001	JHPU PROPORTIONAL FULL FILTRATION (Std) -362 (v4.0)	CTHPU21000
						B	CTHPU21002	JHPU PROPORTIONAL FULL FILTRATION (Std) -391-403-422 (v4.0)	CTHPU21000
						C	CTHPU21003	JHPU PROPORTIONAL FULL FILTRATION (Std) -461-521-571 (v4.0)	CTHPU21000
						D	CTHPU27003	JHPU PROPORTIONAL FULL FILTRATION (STD) - 364 MECS	CTHPU21000
						E	CTHPU21004	JHPU PROPORTIONAL FULL FILTRATION HM571 (v4.0) (RIGHT HAND ROTATION)	CTHPU21000
A1	B1	C1		E1	1		205052	PLUG 1/4" BSPP MALE # Z107004	115000
A1	B1	C1	D1	E1	2		113037	WASHER FOR JHPU MOUNT (TOP)	113037
A1	B1	C1	D1	E1	3		103916	(STUDS) METRIC (316-STST) M12x64 (24/24)	30639
A1	B1	C1	D1	E1	4		107144	(WASHER) SPECIAL (RECTANGULAR)	107144
A1	B1	C1	D1	E1	5		030669	(STUDS) METRIC (316-STST) M12x59 (24/24)	30639
A2	B2	C2	D2	E2	6.1		109199	SHIM (JHPU) 5mm	109199
A2	B2	C2	D2	E2	6.2		109200	SHIM (JHPU) 4mm	109199
A2	B2	C2	D2	E2	6.3		109201	SHIM (JHPU) 3mm	109199
A2	B2	C2	D2	E2	6.4		109202	SHIM (JHPU) 2mm	109199
A2	B2	C2	D2	E2	6.5		109203	SHIM (JHPU) 1mm	109199
A1	B1	C1	D1	E1	7		201311	NUT HEX M12 SS316	N/A
A1	B1	C1	D1	E1	8		201396	WASHER SPRING M12 SS316	N/A
					9	REF	203650	KIT - DANFOSS PRESSURE TRANSDUCER	CTVLV04042
A1	B1	C1		E1	10		112210	(LABELS) WARNING - REPLACE PLUG WITH PRESSURE TRANSDUCER	112210
A1	B1	C1		E1	11		112211	(LABELS) PRESSURE TRANSDUCER	112211
A1	B1	C1		E1	12		064500	CABLE TIE FARNELL PART # 149-327 150LG x 3.5 WIDE	115000
A1					13.1		CTTNK03010	TANK, PUMP AND VALVE BLOCK SUB ASSEMBLY -(362 MECS)	CTTNK03010
	B1	C1			13.2		CTTNK03011	TANK, PUMP AND VALVE BLOCK SUB ASSEMBLY -(391 MECS -571 MECS)	CTTNK03010
			D1		13.3		CTTNK03012	TANK, PUMP AND VALVE BLOCK SUB ASSEMBLY -(364 MECS)	CTTNK03010
				E1	13.4		CTTNK03018	TANK, PUMP AND VALVE BLOCK SUB ASSEMBLY -(571 MECS) RIGHT HAND ROTATION OPTION	CTTNK03010
A1	B1	C1	D1	E1	14		205972	LABEL FOR JHPU (OIL SPECIFICATION)	205971
A1	B1	C1	D1	E1	15		201332	(NUTS) (METRIC NYLOC ST ST 316) M12	N/A
A1	B1	C1	D1	E1	16		110266	BENT TUBE LEVEL SENSOR KIT (362-571)	207333
A1	B1	C1	D1	E1	17		112317	WIKA TEMPERATURE SENSOR KIT	112317
A1			D1		18.1		109233	DRIVEN PULLEY, DIA 99	109233
	B1	C1		E1	18.2		109232	DRIVEN PULLEY, DIA 136	109232
A3	B3	C3	D3	E3	19		201261	(SCREWS) (CAPSCREWS) METRIC ST ST 316 SOCKET HD M8x20	N/A
A3	B3	C3	D3	E3	20		201394	(WASHERS) (SPRING) METRIC ST ST 316 M8	N/A



C. W. F. Hamilton & Co. Ltd

CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS

REVISION: **AG** ECN: **19845**

SHEET 2 ADDED TO SHOW KIT D

DESIGN CHECK:	A.A	2/07/2012	SIGN.:
DRAWING REVISION:	J.S.R.	2/07/2012	SIGN.:
DOCUMENT CHECK:	S.K.	2/07/2012	SIGN.:
ORIGINAL DESIGN:	I.B.W	9/10/1997	SIGN.:

MANUFACTURING INFORMATION

MATERIAL: **N/A**

STANDARD:

MAT CERT REQ: **No** TRACEABILITY REQ: **No**

FINISHED WEIGHT: [kg]

ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED

REMOVE ALL SHARP EDGES & BURRS

UNTOLERANCED DIMENSIONS & SURFACE FINISH

GENERAL: +/- HOLES: Ø ANGULAR: °

MACHINED SURFACE FINISH: Ra µm

DRAWING INFORMATION

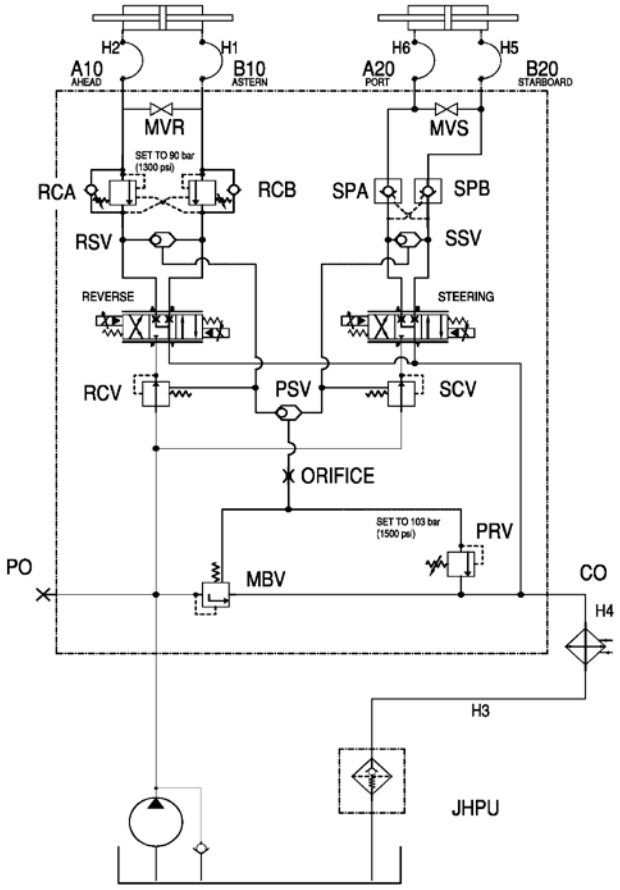
JET HYDRAULIC POWER UNIT REVERSE AND STEERING SYSTEM (MECS)

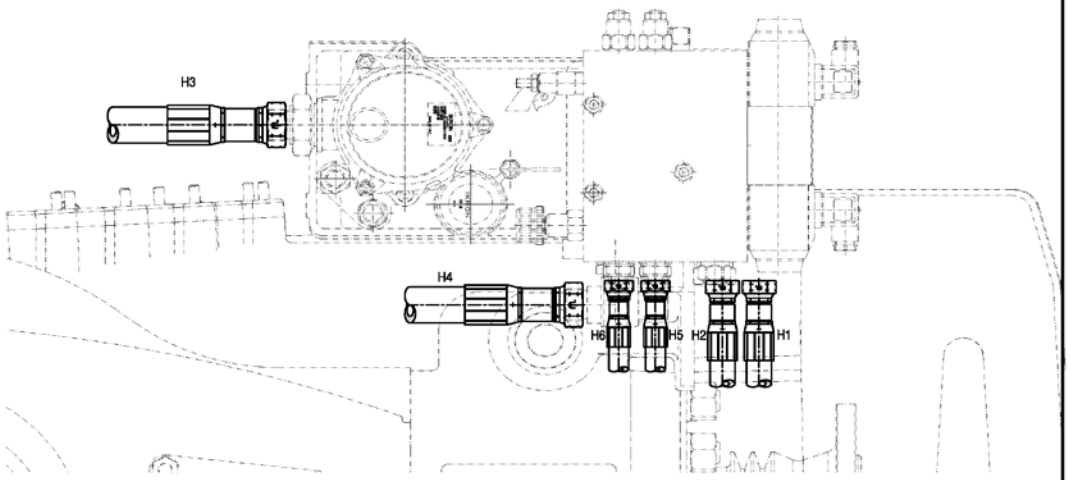
JET / CONTROL TYPE: **362-571**

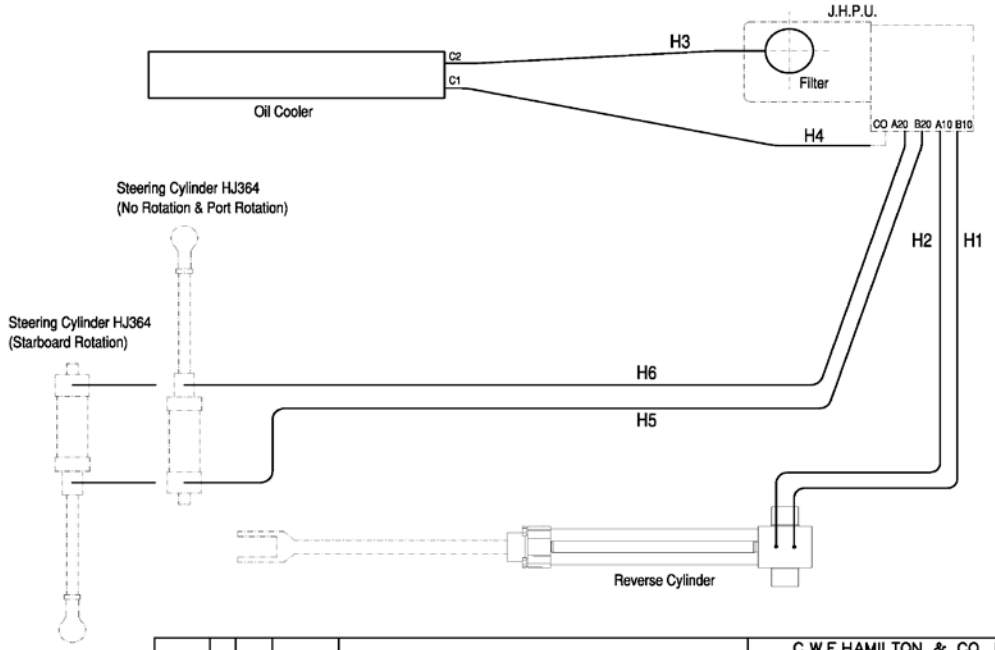
DRAWN TO HAMJET 085195 PROJECTION:

SCALE: **1:20** SHEET SIZE **A3** **Sheet3/3**

DWG No: **CTHPU21000** REV: **AG**







					C.W.F.HAMILTON & CO. LTD. CHCH. NZ.
					PROJECTION
19839	C	J.S.R	28.05.12	DRAWING NUMBER CORRECTED.	NAME: HOSE KITS for MECS HJ364 FULL FILTRATION Sheet 1 of 2
CL633	B	J.S.R	16.08.10	DRAWING UPDATED TO SHOW LABEL POSITION.	DESIGNED P.M.W 15.08.07
CL480	A	P.M.W	20.08.07	ISSUED FOR PRODUCTION	DRAWN P.M.W 15.08.07
REF	NO.	BY	DATE	AMENDMENTS	CHECKED R.K 15.08.07
JET 364					APPROVED
THIS PRINT IS PROVIDED ON A RESTRICTED BASIS AND IS NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTERESTS OF C.W.F.HAMILTON AND CO LTD.					SCALE N.T.S No: ASSY- CT HSE 12 076 C

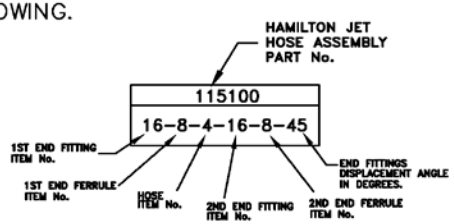
HAMILTON JET (HAM SPEC) HOSE KIT INSTRUCTIONS.

FOR A COMPLETE BREAKDOWN OF ALL PARTS NEEDED TO BUILD THESE KITS THIS DRAWING SHOULD BE USED IN CONJUNCTION WITH DRAWING 115000 Sheets 1 & 2.

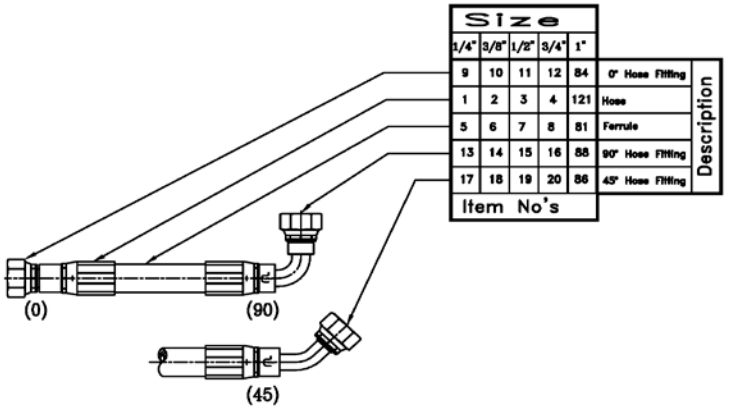
IN THE PARTS LIST ON THIS DRAWING, THE ITEMS REQUIRED TO BUILD EACH HOSE ASSEMBLY ARE LISTED IN EACH HOSE'S DESCRIPTION.

PartNumber	ProductDescription
115100	HOSE 3/4" L=0450mm 90-90 deg **16-8-4-16-8-45**

THE NUMBERS IN THE DESCRIPTION MEAN THE FOLLOWING.

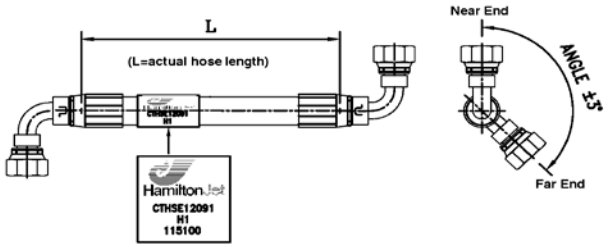


FOR GENERIC DESCRIPTIONS OF COMMON FITTINGS USE THE DIAGRAM BELOW. FOR COMPLETE DESCRIPTIONS OF ALL ITEM NUMBERS REFER TO DRAWING 115000 Sheets 1 & 2.



Notes:

(1) ALL FITTINGS TO BE STAINLESS STEEL
(2) THREAD FORM TO BE B.S.P.P.
(3) HOSE ASSEMBLIES TO BE ASSEMBLED BY TRAINED PERSONAL ONLY.
(4) HOSE ASSEMBLIES TO BE ASSEMBLED AS PER HOSE ASSEMBLY PROCEDURE MANUAL 85167.
(5) ALL HOSES TO BE CLEANED BY THE "AIR MATE" SYSTEM PRIOR TO THE INSERTION OF FITTINGS.



EACH HOSE MUST HAVE A HOSE LABEL SHOWING THE HOSE KIT NUMBER, 'H' NUMBER, AND HOSE PART NUMBER AS SHOWN ABOVE.

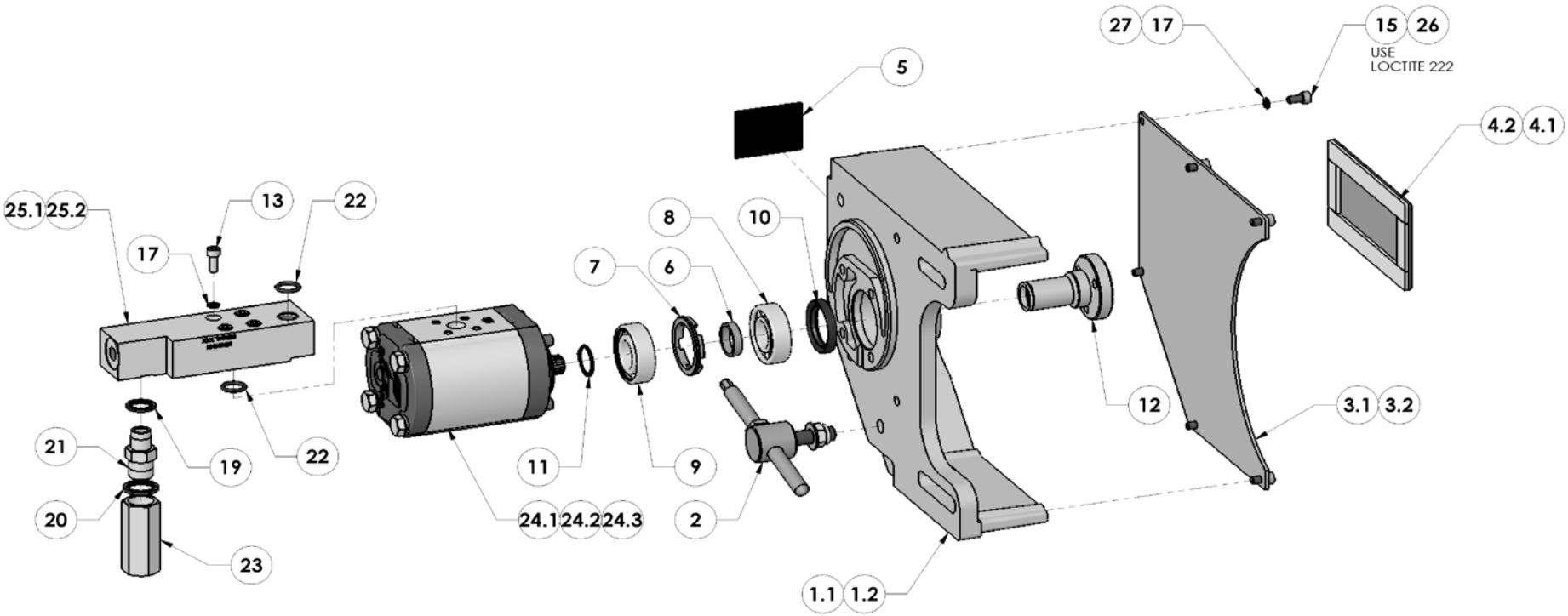
Displacement Angle

Specified only if two elbow fittings are used. Starting with either end as the near end, measure the angle clockwise to describe the displacement.

A	Item	Kit	Part Number	Product Description	Drawing
		A	CTHSE12076	MECS HOSE KIT (FULL FILLTRATION) 364	CTHSE12076
A1	364	H1	206728	HOSE 1/4" L=0300mm 45-90 deg 17-5-1-13-5-140	CTHSE12076
A1	364	H2	206729	HOSE 1/4" L=0300mm 45-90 deg 17-5-1-13-5-140	CTHSE12076
A1	364	H3	206732	HOSE 1/2" L=0255mm 00-45 deg 11-7-3-19-7-0	CTHSE12076
A1	364	H4	206733	HOSE 1/2" L=0465mm 45-90 deg 19-7-3-15-7-90	CTHSE12076
A1	364	H5	206735	HOSE 1/4" L=0715mm 45-90 deg 17-5-1-13-5-270	CTHSE12076
A1	364	H6	206736	HOSE 1/4" L=0675mm 45-90 deg 17-5-1-13-5-270	CTHSE12076

REF NO. BY DATE — REFER TO SHEET 1 FOR AMENDMENTS — AMENDMENTS
JET 364

C.W.F.HAMILTON & CO. LTD. CHCH. NZ.
PROJECTION
DESIGNED P.M.W 15.08.07
DRAWN P.M.W 15.08.07
CHECKED
APPROVED
NAME: HOSE KITS for MECS HJ364 FULL FILTRATION Sheet 2 of 2
SCALE -
No: ASSY-CT HSE 12 076 C



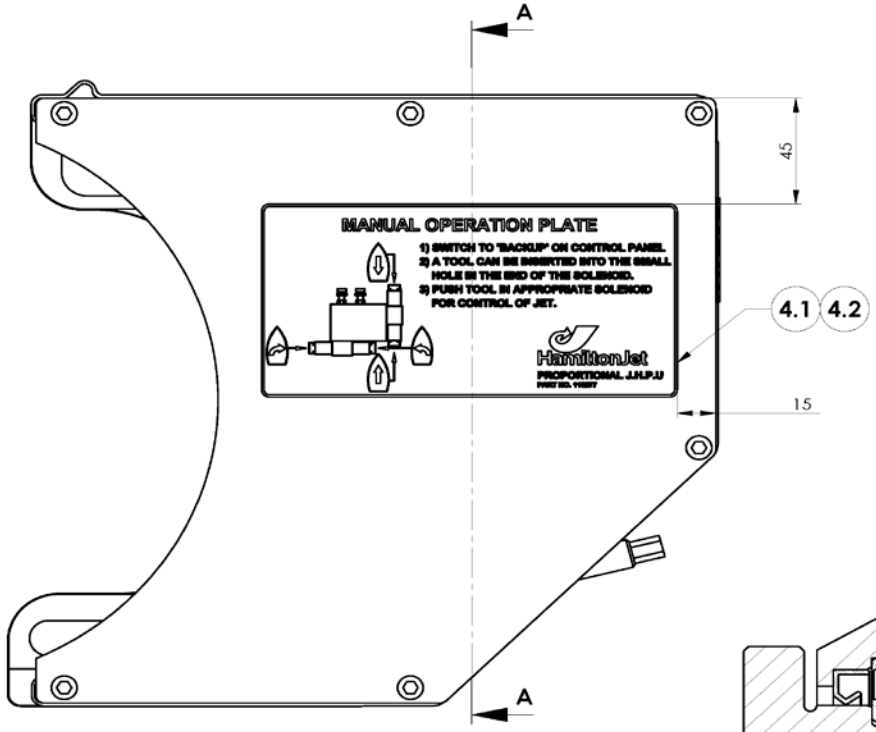
HamiltonJet

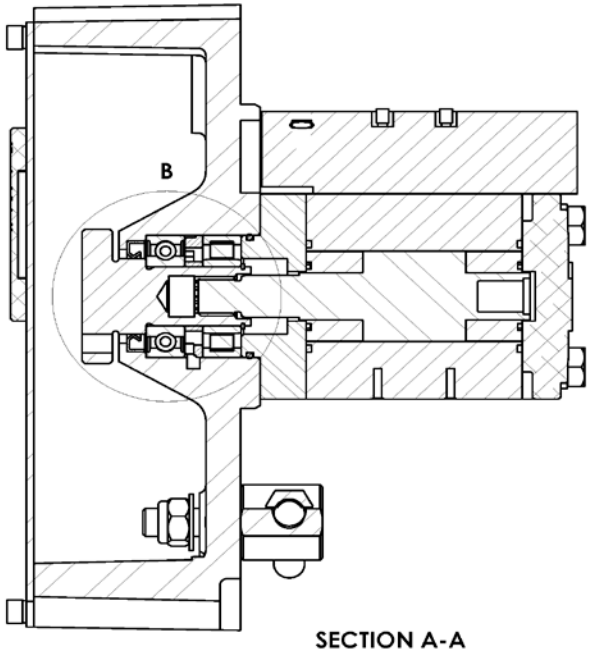
This print is provided on a restricted basis and is not to be used in any way detrimental to the interests of C. W. F. Hamilton and Co. Ltd

CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS				
REVISION: C ECN: 20496				
DRAWING DESCRIPTION AND DESCRIPTION ON KIT D REVISED TO INCLUDE AVX CONTROL SYSTEMS				
DESIGN CHECK:	N.T	5/12/2012	SIGN.	
DRAWING REVISION:	J.S.R.	4/12/2012	SIGN.	
DOCUMENT CHECK:	N.T	5/12/2012	SIGN.	
ORIGINAL DESIGN:	J.S.R.	6/02/2012	SIGN.	

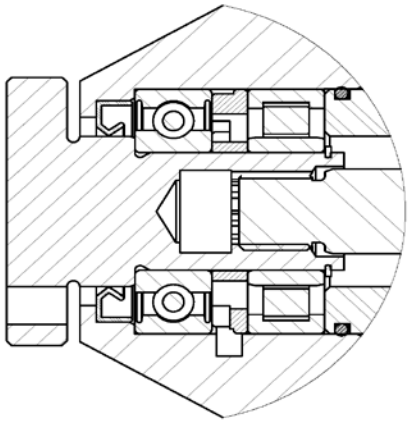
MANUFACTURING INFORMATION
MATERIAL:
STANDARD:
MAT CERT REQ: No TRACEABILITY REQ: No
FINISHED WEIGHT: [kg]
ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED
REMOVE ALL SHARP EDGES & BURRS
UNTOLERANCED DIMENSIONS & SURFACE FINISH GENERAL: +/- n/a HOLES: ∅0.2 ANGULAR: 0.5° MACHINED SURFACE FINISH: Ra n/a µm

DRAWING INFORMATION		
PUMP ASSEMBLY JHPU for MECS, blue ARROW HYRC/HFRC and AVX		
JET / CONTROL TYPE: 362,364,391,403,422,461,521,571		
DRAWN TO HAMJET 085195	PROJECTION:	
SCALE: 1:3.5	SHEET SIZE A3	Sheet1/3
DWG No: CTPMP01010	REV:	C

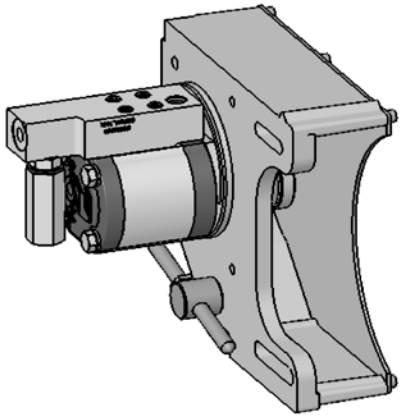




SECTION A-A



DETAIL B



HamiltonJet						
CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS					MANUFACTURING INFORMATION	DRAWING INFORMATION
REVISION: C ECN: 20496					MATERIAL:	PUMP ASSEMBLY JHPU
DRAWING DESCRIPTION AND DESCRIPTION ON KIT D REVISED TO INCLUDE AVX CONTROL SYSTEMS					STANDARD:	for MECS, blue ARROW HYRC/HFRC and AVX
					MAT CERT REQ: No TRACEABILITY REQ: No	
					FINISHED WEIGHT: [kg]	
DESIGN CHECK:	N.T	5/12/2012	SIGN.		ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED	JET / CONTROL TYPE: 362,364,391,403,422,461,521,571
DRAWING REVISION:	J.S.R.	4/12/2012	SIGN.		REMOVE ALL SHARP EDGES & BURRS	DRAWN TO HAMJET 085195 PROJECTION:
DOCUMENT CHECK:	N.T	5/12/2012	SIGN.		UNTOLERANCED DIMENSIONS & SURFACE FINISH GENERAL: +/- n/a HOLES: Ø 0.2 ANGULAR: 0.5°	SCALE: 1:2 SHEET SIZE A3 Sheet2/3
ORIGINAL DESIGN:	J.S.R.	6/02/2012	SIGN.		MACHINED SURFACE FINISH: Ra n/a µm	DWG No: CTPMP01010 REV: C

A	B	C	D	E	F	G	Item	Kit	Part Number	Product Description	Drawing
								A	CTPMP01010	PUMP ASSEMBLY FOR JHPU (362 MECS AND 364 MECS)	CTPMP01010
								B	CTPMP01011	PUMP ASSEMBLY FOR JHPU (391 MECS -571 MECS)	CTPMP01010
								C	CTPMP01013	PUMP ASSEMBLY FOR JHPU (403 BLUE ARROW)	CTPMP01010
								D	CTPMP01014	PUMP ASSEMBLY FOR JHPU (364 BLUE ARROW AND 364 AVX)	CTPMP01010
								E	CTPMP01015	PUMP ASSEMBLY FOR JHPU (364 HYRC/HFRC)	CTPMP01010
								F	CTPMP01016	PUMP ASSEMBLY FOR JHPU (403 - 571 HYRC/HFRC)	CTPMP01010
								G	CTPMP01017	PUMP ASSEMBLY FOR JHPU (571 R.H ROTATION)	CTPMP01010
	B1	C1			F1			H	202384	SPLINED JHPU DRIVE UPGRADE KIT-391, 403, 422, 461, 521, 571	CTHPU21000
A1			D1	E1				J	202385	SPLINED JHPU DRIVE UPGRADE KIT-HJ362	CTHPU21000
						G1		K	210802	SPLINED JHPU DRIVE UPGRADE KIT- 571 R.H ROTATION	CTHPU21000
								L	204994	SEAL KIT #62046611 FOR CASAPPA PLP20-11.2-DO PUMP	N/A
								M	204995	SEAL KIT #62046621 FOR CASAPPA PLP20.25-RO PUMP	N/A
A1	B1	C1	D1	E1	F1		1.1		113038	FRONT PLATE JHPU	113038
						G1	1.2		110082	FRONT PLATE, PUMP (RIGHT HAND ROTATION).	110082
A1	B1	C1	D1	E1	F1	G1	2		109428	BELT TENSIONER J.H.P.U. 321 THRU TO 571	109428
A1	B1	C1	D1	E1	F1		3.1		107252	BELT GUARD	107252
						G1	3.2		110127	BELT GUARD (JHPU FRONT PLATE RIGHT HAND ROTATION)	110127
A1	B1					G1	4.1		110277	(LABELS) (MANUAL OPERATION) J.H.P.U. (MECS)	110277
		C1	D1				4.2		210347	(LABELS) (MANUAL OPERATION) J.H.P.U. - BLUE ARROW VERSION	210347
A1	B1	C1	D1	E1	F1	G1	5		063097	(LABELS) (MODEL & SERIAL No PLATE)	63097
A1	B1	C1	D1	E1	F1	G1	6		109234	BEARING SPACER (INNER)	109234
A1	B1	C1	D1	E1	F1	G1	7		109235	BEARING SPACER (OUTER)	109235
							8		061504	(SKF) BEARINGS ALL TYPES (SKF NU205EC)	N/A
							9		061503	(SKF) BEARINGS ALL TYPES (SKF 6205)	N/A
							10		061505	(OIL SEALS) NAK SCW10-32*47*7	N/A
							11		201401	(CIRCLIPS) EXTERNAL SEEGAR (A25) 25mm	N/A
							12		112514	SPLINED STUB SHAFT FOR CASAPPA PUMP	112514
A4	B4	C4	D4	E4	F4	G4	13		201259	SCREW CAP SOCKET M6x40 SS316	N/A
A6	B6	C4	D4	E6	F6	G6	15		030829	(SCREWS) (CAPSCREWS) METRIC ST ST 316 SOCKET HD M6x12	N/A
A10	B10	C8	D8	E10	F10	G10	17		201392	WASHER SPRING M6 SS316	N/A
A1	B1	C1	D1	E1	F1	G1	19		201767	BONDED SEAL 3/8" BSP (# 400-823-4490-74)	N/A
A3	B3	C3	D3	E3	F3	G3	20		201768	BONDED SEAL 1/2" BSP (# 400-825-4490-74)	N/A
A1	B1	C1	D1	E1	F1	G1	21		205066	NIPPLE 3/8" BSPP MALE x 1/2" BSPP MALE (# Z10200608)	N/A
A2	B2	C2	D2	E2	F2	G2	22		200960	(O RINGS) IMPERIAL 0.10x0.63x0.81 (114N70)	N/A
A1	B1	C1	D1	E1	F1	G1	23		064270	CHECK VALVE (CA13 FIMMA)	64270
							24.1		065343	(HYDRAULIC) PUMPS CASAPPA, POLARIS PLP20.11,2-DO-12B6-LBE/BC-N-EL	N/A
							24.2		065344	(HYDRAULIC) PUMPS CASAPPA, POLARIS PLP20.25-RO-12B6-LBE/BC-N-EL-MD	N/A
							24.3		206679	CASAPPA PLP SERIES REVERSIBLE PUMP	206679
A1			D1	E1			25.1		111085	(HYDRAULIC) JHPU VALVE BLOCKS 'P' PORT BLOCK (J.H.P.U. MK 11) 11.2 cc CASAPPA PUMP	111085
	B1	C1			F1	G1	25.2		110311	(HYDRAULIC) JHPU VALVE BLOCKS 'P' PORT BLOCK (J.H.P.U. MK II) 25cc CASAPPA PUMP	110311
		C2	D2				26		065146	(SCREWS) (SET SCREWS) METRIC ST ST 316 SOCKET M6x45	N/A
		C2	D2				27		201382	(WASHERS) (FLAT) METRIC ST ST 316 M6x12.5x1.0	N/A

C

HamiltonJet

CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS

REVISION: C ECN: 20496

DRAWING DESCRIPTION AND DESCRIPTION ON KIT D REVISED TO INCLUDE AVX CONTROL SYSTEMS

DESIGN CHECK:	N.T	5/12/2012	SIGN.
DRAWING REVISION:	J.S.R.	4/12/2012	SIGN.
DOCUMENT CHECK:	N.T	5/12/2012	SIGN.
ORIGINAL DESIGN:	J.S.R.	6/02/2012	SIGN.

MANUFACTURING INFORMATION

MATERIAL:

STANDARD:

MAT CERT REQ: No TRACEABILITY REQ: No

FINISHED WEIGHT: [kg]

ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED

REMOVE ALL SHARP EDGES & BURRS

UNTOLERANCED DIMENSIONS & SURFACE FINISH

GENERAL: +/- n/a HOLES: ∅0.2 ANGULAR: 0.5°

MACHINED SURFACE FINISH: Ra n/a µm

DRAWING INFORMATION

PUMP ASSEMBLY JHPU for MECS, blue ARROW HYRC/HFRC and AVX

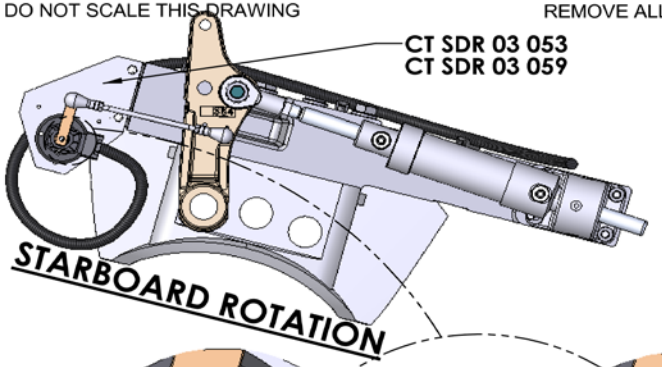
JET / CONTROL TYPE: 362,364,391,403,422,461,521,571

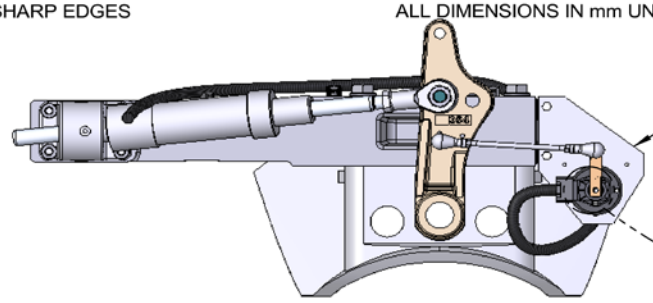
DRAWN TO HAMJET 085195 PROJECTION:

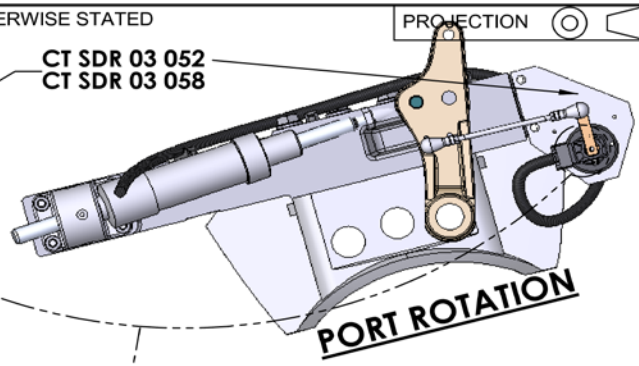
SCALE: 1:3.5 SHEET SIZE A3 Sheet3/3

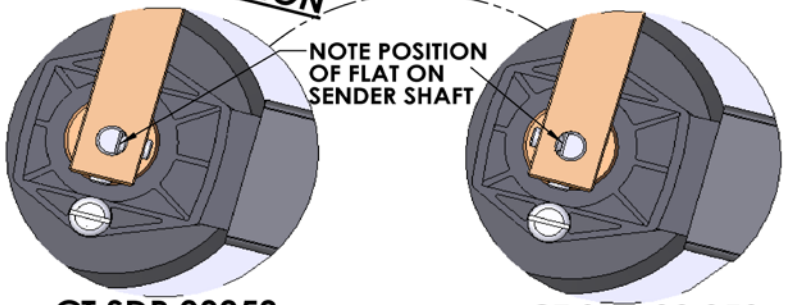
DWG No: CTPMP01010 REV: C

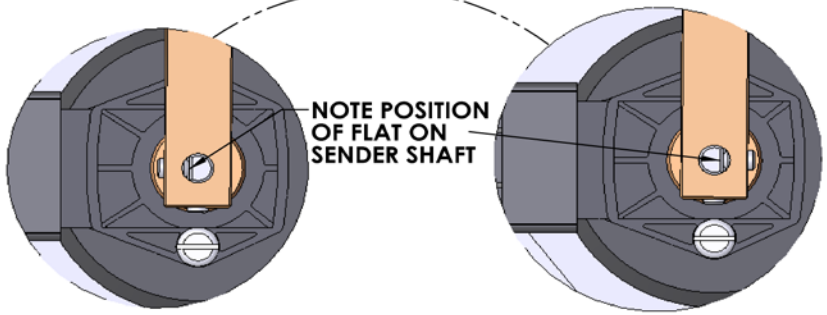
DO NOT SCALE THIS DRAWING | REMOVE ALL SHARP EDGES | ALL DIMENSIONS IN mm UNLESS OTHERWISE STATED | PROJECTION

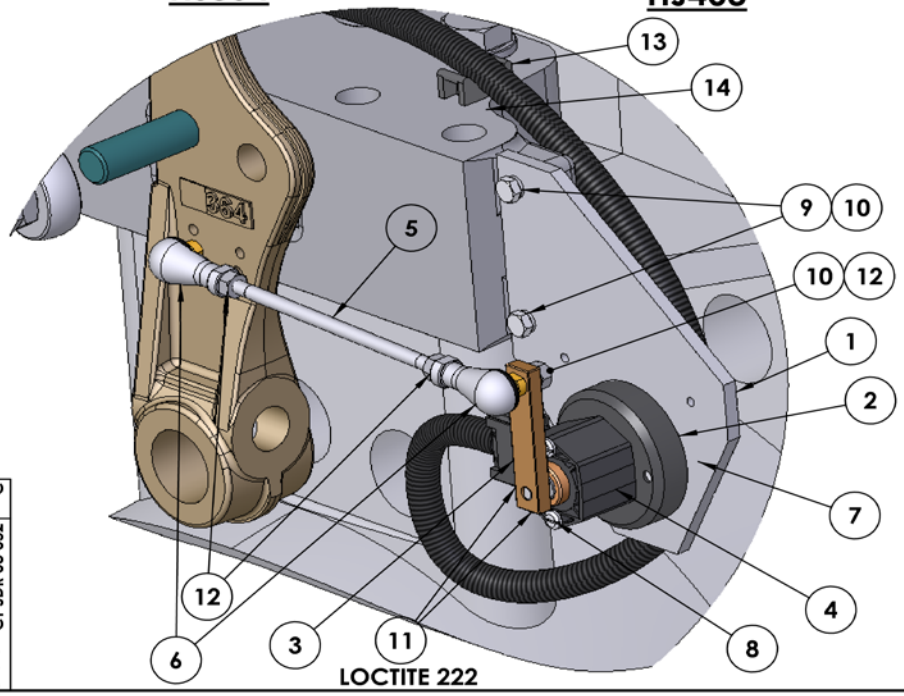












A	Item	Kit	PartNumber	MovexAlias	Qty	ProductDescription	DrawingNbr
		A	CTSDR03059			INDUCTIVE SENDER STEERING STARBOARD ROTATED (HALL ANGLE) 403	CTSDR03052
		A	CTSDR03058			INDUCTIVE SENDER STEERING NON ROTATED & PORT ROTATION (HALL ANGLE) 403	CTSDR03052
		A	CTSDR03053			INDUCTIVE SENDER STEERING STARBOARD ROTATED (HALL ANGLE) 364	CTSDR03052
		A	CTSDR03052			INDUCTIVE SENDER STEERING NON ROTATED & PORT ROTATION (HALL ANGLE) 364	CTSDR03052
A	1		112384		1	STEERING SENDER BRACKET (VDO. AB & POSITEC)	112384
A	2		113040		1	MOUNT BLOCK A B SENDER for BLUE ARROW	113040
A	3		113039		1	ARM FOR A.B. SENDER	113039
A	4		204148		1	HALL ANGLE ROTARY SENDER	N/A
A	5		30795	030795	1	(STUDS) METRIC (316-STST) M6x144 (25/25)	30635
A	6		JNOGABP	201475	2	ROD ENDS (RBL-6D-THK)	N/A
A	7		HZQHXAH	201213	2	(SCREWS) (M/C SCREWS) METRIC ST ST 316 HEX HD M6x20	N/A
A	8		30758	030758	2	(BOLTS) (M/C SCREWS) METRIC STST 316 M4x40 (PAN HD)	N/A
A	9		HZQHXAE	201212	2	(SCREWS) (M/C SCREWS) METRIC ST ST 316 HEX HD M6x16	N/A
A	10		JEQKXAA	201392	3	(WASHERS) (SPRING) METRIC ST ST 316 M6	N/A
A	11		30780	030780	2	(SCREWS) (SET SCREWS) METRIC ST ST 316 Socket M4x6	N/A
A	12		JDQHXAA	201308	3	(NUTS) (METRIC ST ST 316) M6	N/A
A	13		205510		3	CABLE TIE MOUNT HELLERMANN TYTON 357-6395	N/A
A	14		HZPRXBP	201207	3	(SCREWS) (M/C SCREWS) METRIC ST ST 316 M5x10 (PAN HEAD)	N/A

C. W. F. Hamilton & Co. Ltd, Christchurch, New Zealand

AMENDMENT
C - ITEM 14 CHANGED FROM M6 TO M5 BOLT
B - ASSEMBLIES FOR 403 ADDED

ECN CL460 | BY P.M.W | DATE 2/04/2006
JET 364, 403

MATERIAL | Certified No | Weight [kg] | √ = N9 EXCEPT AS STATED
Cast | UNLIMITED DIMENSION TO BE ±0.5 | Scale 1:2.5
M/C | DESCRIPTION
Standard
Approvals

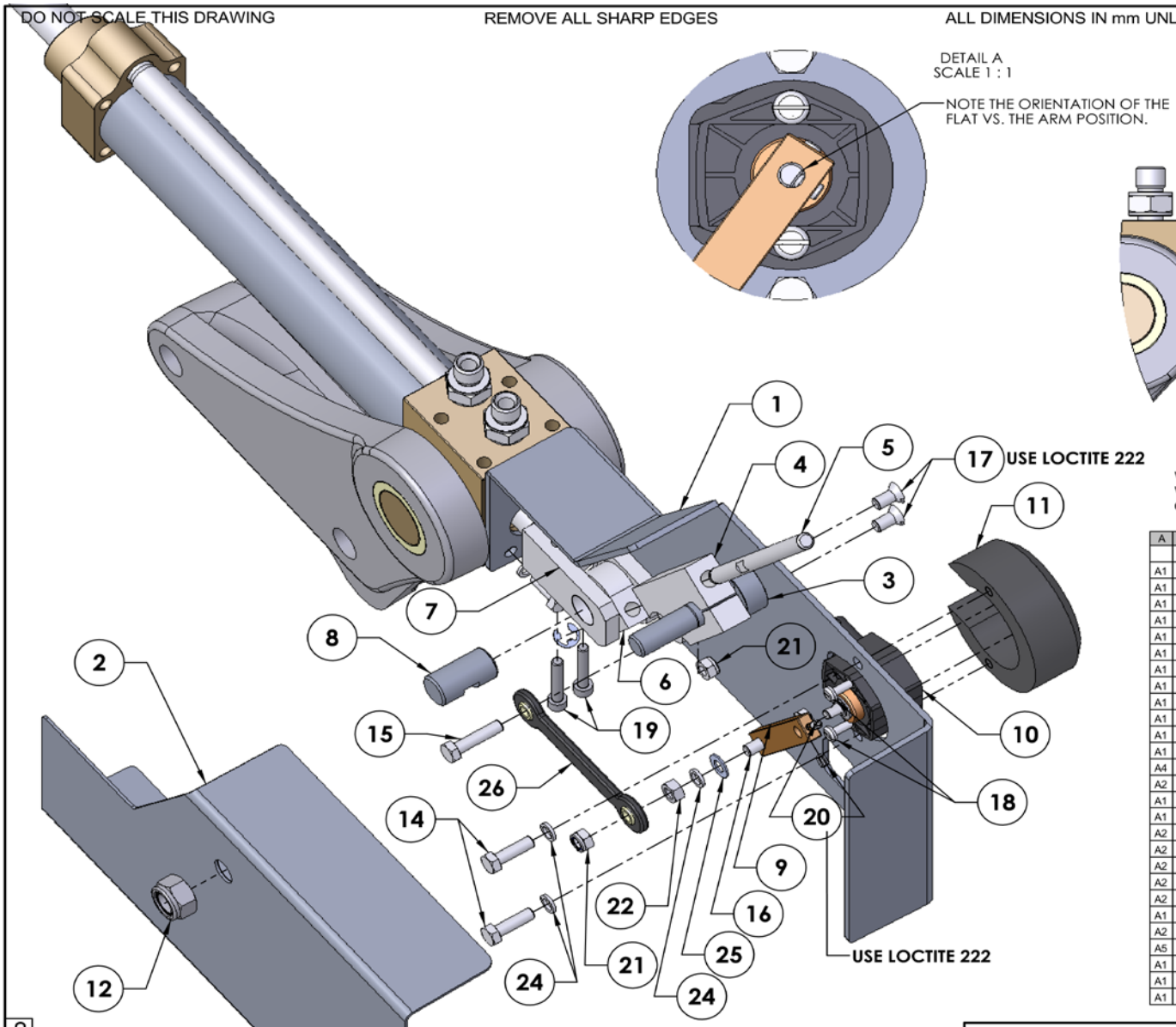
	Name	Date
Designed	P.S.	3/11/2005
Reviewed		31/12/2000

STEERING SENDER
BLUE ARROW & MECS
HJ364 & 403

DWG No CT SDR 03 052 Sheet1/1 C

DWG No CT SDR 03 052 C

DO NOT SCALE THIS DRAWING | REMOVE ALL SHARP EDGES | ALL DIMENSIONS IN mm UNLESS OTHERWISE STATED | PROJECTION



ELEVATION WITH COVER REMOVED

WHEN THE END OF THE CLEVIS (ITEM 7) IS IN LINE WITH THE HOLES IN THE MOUNT PLATE (ITEM 1) THE CYLINDER IS 5mm FROM EACH END OF ITS STROKE.

A	Item	Kit	PartNumber	ProductDescription	DrawingNbr
		A	CTSDR03054	INDUCTIVE SENDER REVERSE (HALL ANGLE)	CTSDR03054
A1	1		113041	MOUNT BRACKET REVERSE SENDER HJ364	113041
A1	2		113043	COVER FOR REVERSE SENDER HJ364	113043
A1	3		113046	PIVOT POST	113046
A1	4		113042	SLIDER BLOCK A B SENDER REVERSE HJ364	113042
A1	5		113047	FEEDBACK ROD FOR REVERSE SENDER HJ364	113047
A1	6		112986	FEEDBACK PIVOT BLOCK 364	112986
A1	7		112985	CLEVIS for FEEDBACK LINK 364	112985
A1	8		112987	CLEVIS PIN	112987
A1	9		113039	ARM FOR A.B. SENDER	113039
A1	10		204148	HALL ANGLE ROTARY SENDER	N/A
A1	11		113045	MOUNT BLOCK FOR A. B. SENDER - REVERSE - HJ364	113045
A1	12		201332	(NUTS) (METRIC NYLOC ST ST 316) M12	N/A
A4	13		201212	(SCREWS) (M/C SCREWS) METRIC ST ST 316 HEX HD M6x16	N/A
A2	14		201213	(SCREWS) (M/C SCREWS) METRIC ST ST 316 HEX HD M6x20	N/A
A1	15		201214	(SCREWS) (M/C SCREWS) METRIC ST ST 316 HEX HD M6x25	N/A
A1	16		204595	(SCREWS) (M/C SCREWS) METRIC ST ST 316 HEX HD M6x30	N/A
A2	17		201199	(BOLTS) (M/C SCREWS) METRIC STST 316 M6x12 (CSK HD)	N/A
A2	18		204077	(BOLTS) (M/C SCREWS) METRIC STST 316 M4 x 35 (PAN HD)	N/A
A2	19		30738	(SCREWS) (CAPSCREWS) METRIC ST ST 316 Socket Hd M5x30	N/A
A2	20		30780	(SCREWS) (SET SCREWS) METRIC ST ST 316 Socket M4x6	N/A
A2	21		201329	(NUTS) (METRIC NYLOC ST ST 316) M6	N/A
A1	22		201308	NUT HEX M6 SS316	N/A
A2	23		30845	(NUTS) (METRIC NYLOC ST ST 316) M5	N/A
A5	24		201392	WASHER SPRING M6 SS316	N/A
A1	25		201382	WASHER FLAT M6x12.5x1.0 SS316	N/A
A1	26		205467	BEARING TWIN PIVOT (LINK BAR) IGUS EGZM-06-75	N/A
A1	27		204623	CIRCLIP E TYPE Ø8mm SHAFT SS304	N/A

DWG No CT SDR 03 054 D

C. W. F. Hamilton & Co. Ltd, Christchurch, New Zealand

AMENDMENT
D - ITEM 9 (ARM FOR AB SENDER) HAS BEEN ROTATED 180 DEG.

ECN CL523 | BY M.S. | DATE 23/06/2008
JET HJ364

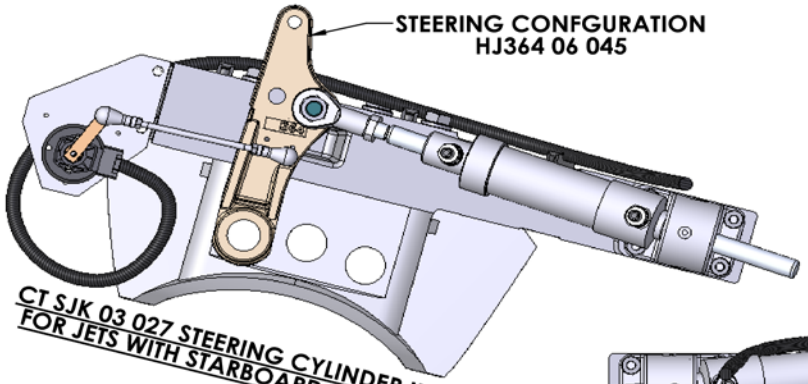
MATERIAL | Certified No | Weight [kg] | √ = N9 EXCEPT AS STATED
Cast | UNLIMITED DIMENSION TO BE ±0.5 | Scale 1:2
M/C | DESCRIPTION
Standard
Approvals

	Name	Date
Designed	P.S.	1/11/2005
Reviewed	S.K.	1/04/2008

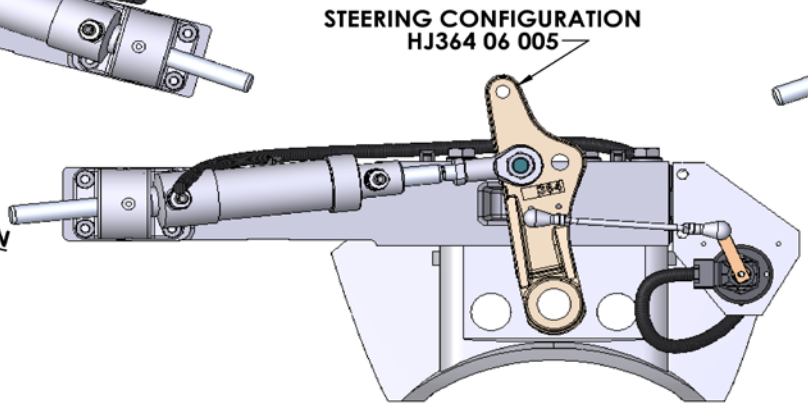
REVERSE SENDER
BLUE ARROW & MECS
HJ364

DWG No CT SDR 03 054 Sheet1/1 D

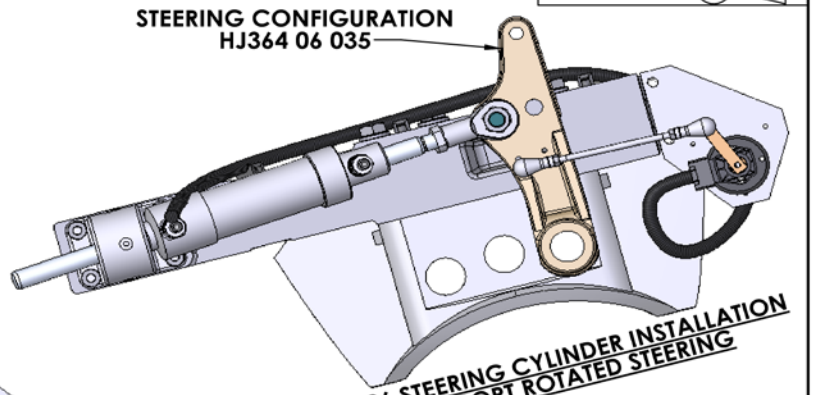
DO NOT SCALE THIS DRAWING | REMOVE ALL SHARP EDGES | ALL DIMENSIONS IN mm UNLESS OTHERWISE STATED | PROJECTION



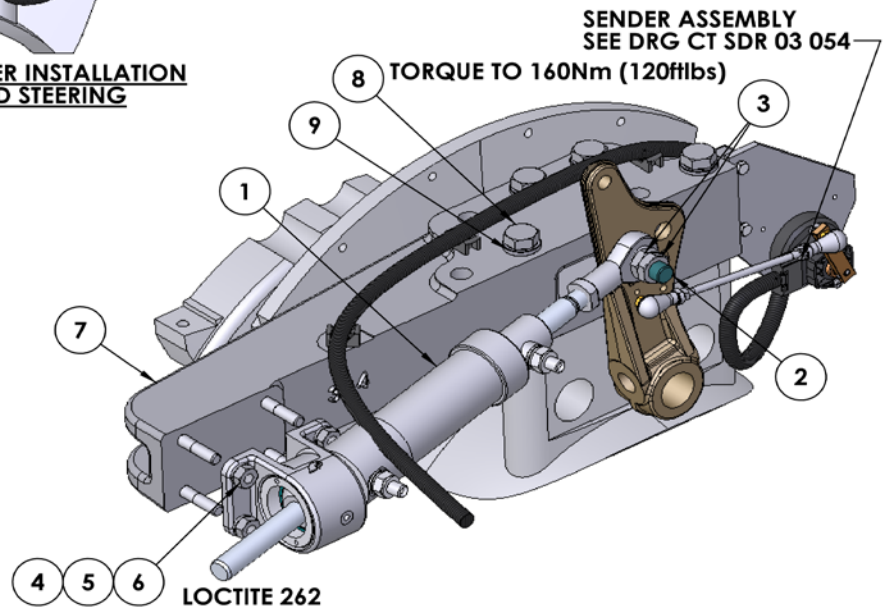
CT SJK 03 027 STEERING CYLINDER INSALLATION
FOR JETS WITH STARBOARD ROTATED STEERING



CT SJK 03 025 STEERING CYLINDER INSTALLATION
FOR JET WITH NON-ROTATED STEERING



CT SJK 03 026 STEERING CYLINDER INSTALLATION
FOR JET WITH PORT ROTATED STEERING



A	B	C	Item	Kit	PartNumber	MovexAlias	Qty	ProductDescription	DrawingNbr
				A	CTSJK03025			STEERING CYLINDER PWR HELM CENTRE	CTSJK 03025
				A	CTSJK03026			STEERING CYLINDER PWR HELM ROTATED PORT (Hamilton Cylinder)	CTSJK 03025
				A	CTSJK03027			STEERING CYLINDER PWR HELM ROTATEDSTBD (Hamilton Cylinder)	CTSJK 03025
A				B	113006			STEERING BACKET KIT HJ364 (WAGNER & HAMILTON CYLINDER)	CTSJK01026
A				C	112546			STEERING CYLINDER KIT(HAMILTON CYLINDER) 120mm STROKE	CTSJK03022
		C	1		108643		1	STEERING CYLINDER ASSEMBLY (HAMILTON 120 STROKE)	CTSJK03003
		C	2		HYQHXIO	201161	1	(BOLTS) (METRIC) ST ST 316 M16x60	N/A
		C	3		JDQKXAJ	201323	2	(NUTS) (HALF NUTS) M16 (316 STST)	N/A
	B		4		JCQHXAN	201280	4	(STUDS) METRIC (316-STST) M10x40 (15/20)	30637
	B		5		JDQHXAE	201310	4	(NUTS) (METRIC ST ST 316) M10	N/A
	B		6		JEQKXAE	201395	4	(WASHERS) (SPRING) METRIC ST ST 316 M10	N/A
	B		7		113004		1	STEERING CYLINDER BRACKET HJ364	113004
	B		8		65321	065321	4	(BOLTS) (METRIC) ST ST 316 M16x130	N/A
	B		9		103451		4	(WASHER) SPECIAL M16 316 STST	103451

A | CT SJK 03 025 | DWG No

C. W. F. Hamilton & Co. Ltd, Christchurch, New Zealand

AMENDMENT: A - ISSUED FOR PRODUCTION

ECN: CL394 | BY: P.S. | DATE: 14/11/2005

JET: 364

MATERIAL | Certified: No | Weight [kg] | √ = N9 EXCEPT AS STATED

Cast | UNLIMITED DIMENSION TO BE ±0.5 | Scale 1:4

M/C | DESCRIPTION

Standard | Approvals

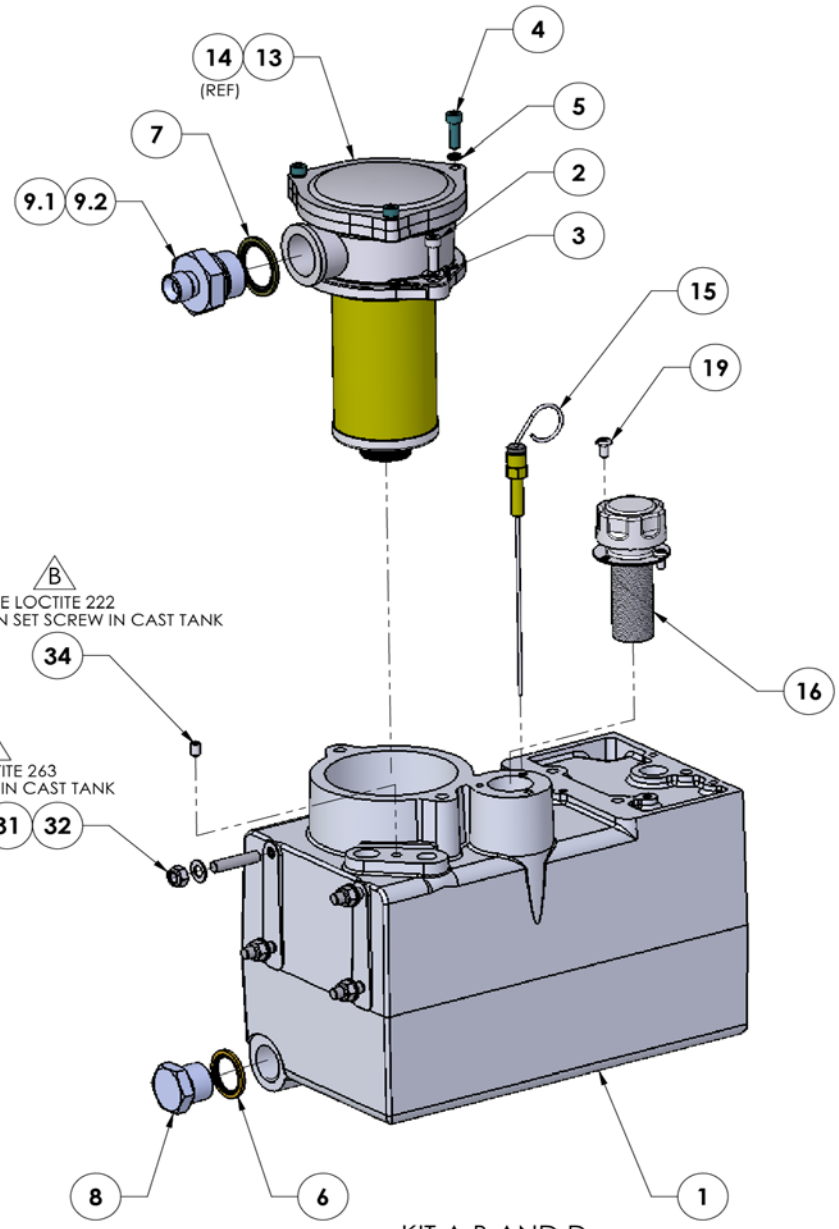
STEERING CYLINDER
POWER STEERING (HAMILTON)
HJ364

	Name	Date
Designed	P.S.	9/11/2005
Reviewed		1/01/2001

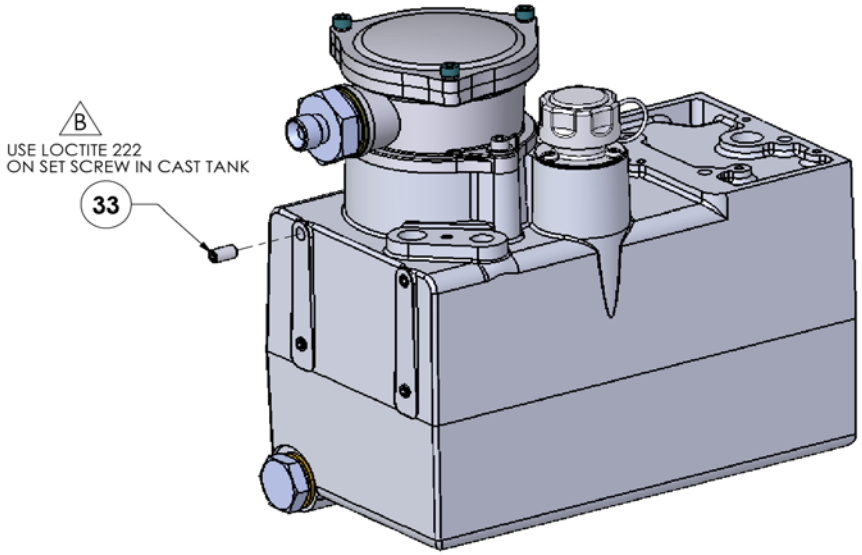
DWG No CT SJK 03 025 Sheet1/1 A

ASSEMBLY STEP 1
FIT TANK MOUNT COMPONENTS

DISCARD ORIGINALS AND
REPLACE WITH S.S



KIT A,B AND D



KIT C

DWG No CTTNK03010 B

C. W. F. Hamilton & Co. Ltd

CHANGE HISTORY				
LATEST AMENDMENT: B - NEW KIT D CREATED, REMOVED ITEM 21 AND ADDED ITEM NO. 30,31,32,33,34 TO BOM. A - ISSUED FOR PRODUCTION				
AMENDED BY:	J.S.R.	05/03/12	ECN:	CL709
AMENDMENT REVIEW:	S.K	05/03/12		
DESIGNED BY:	J.S.R	06/02/12	ECN:	CL706
DESIGN REVIEW:	S.K	06/02/12		

MANUFACTURING INFORMATION

MATERIAL: N/A

STANDARD:

MAT. CERT REQ.: No TRACEABILITY REQ.: No

WEIGHT: CAST [kg]: MACHINED [kg]:

ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED

UNTOLERANCED DIMENSIONS & SURFACE FINISH
GENERAL: +/- n/a HOLES Ø: +/- 0.2 ANGULAR: +/- 0.5°
MACHINED SURFACE FINISH: Ra n/a µm

DRAWING INFORMATION

TANK,PUMP AND VALVE BLOCK ASSEMBLY (MECS)

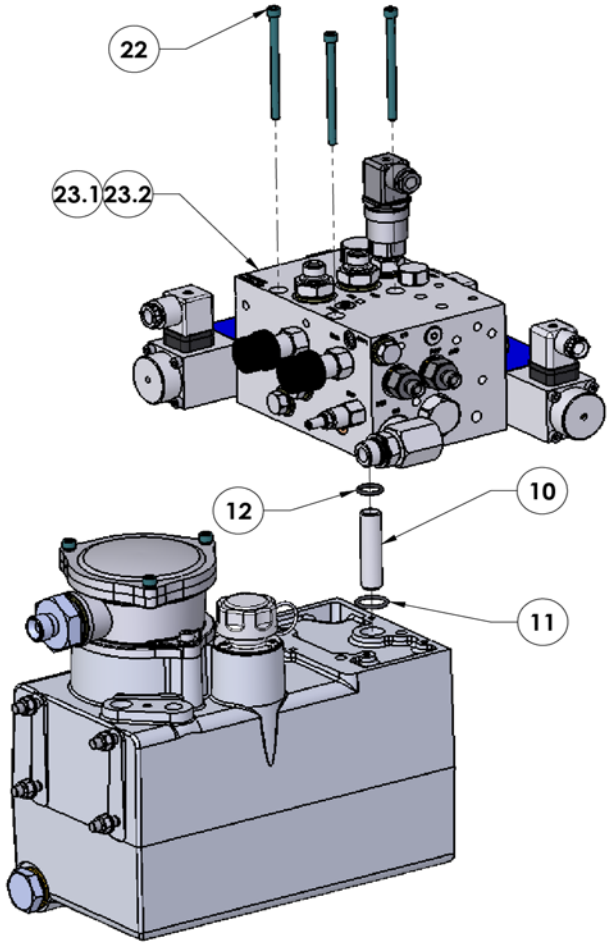
JET / CONTROL TYPE: 362-571

DRAWN TO HAMJET 085195 PROJECTION:

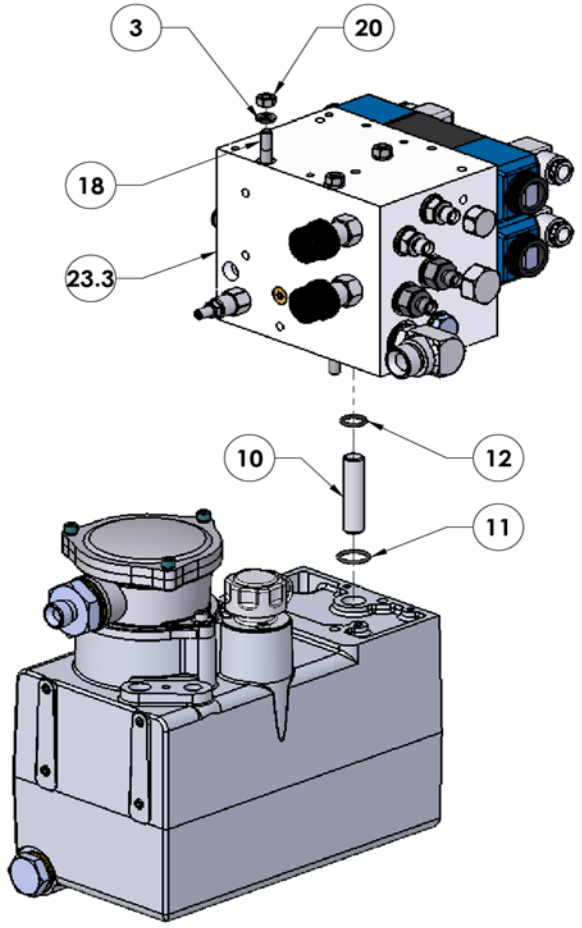
SCALE: 1:3 SHEET SIZE A3 Sheet1/5

DWG No.: CTTNK03010 REV: B

ASSEMBLY STEP 2
FIT VALVE BLOCK ASSEMBLY



KIT A,B AND D



KIT C

DWG No CTTNK03010 B

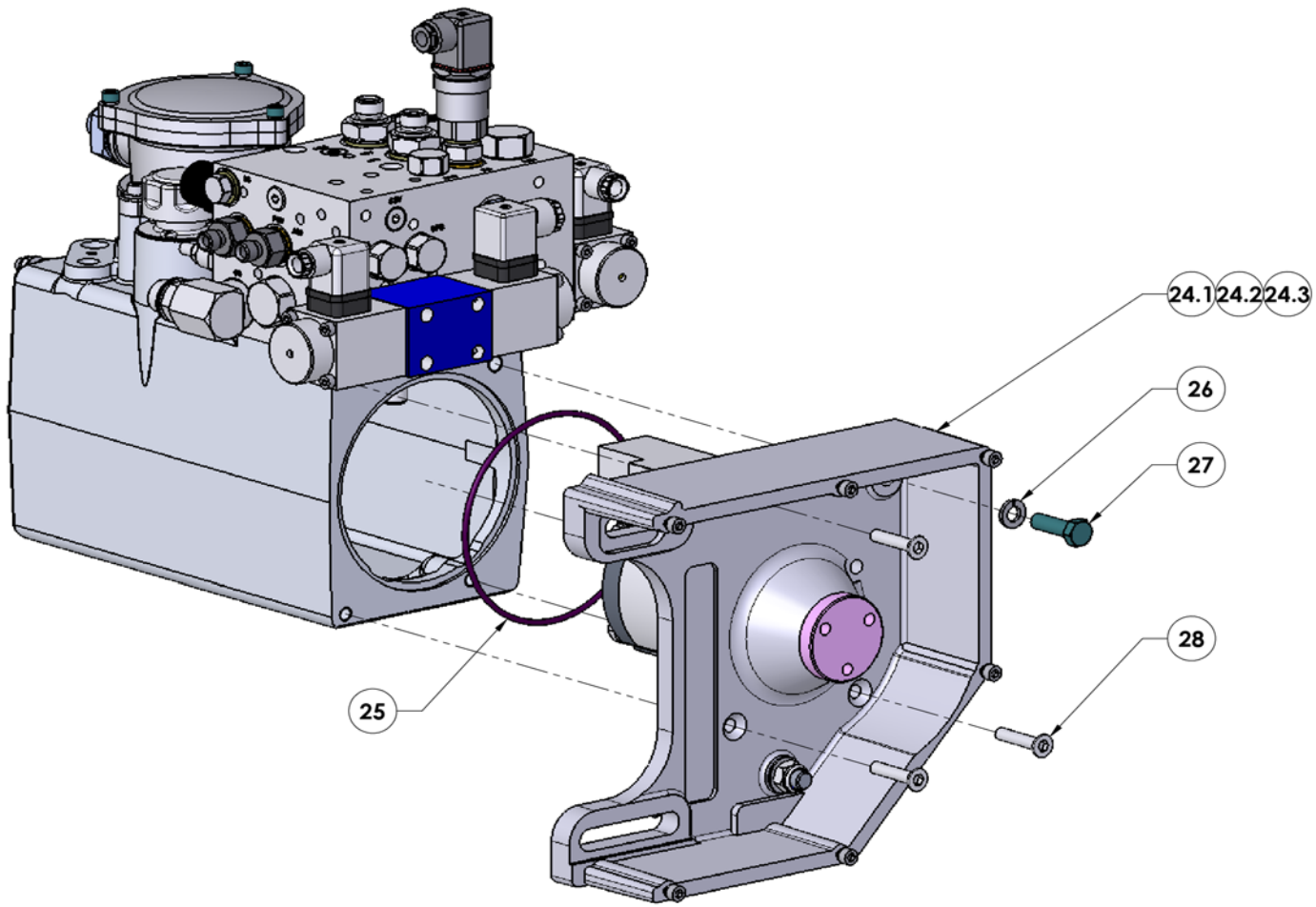
C. W. F. Hamilton & Co. Ltd

CHANGE HISTORY				
LATEST AMENDMENT: B - NEW KIT D CREATED, REMOVED ITEM 21 AND ADDED ITEM NO. 30,31,32,33,34 TO BOM. A - ISSUED FOR PRODUCTION				
AMENDED BY:	J.S.R.	05/03/12	ECN:	CL709
AMENDMENT REVIEW:	S.K	05/03/12		
DESIGNED BY:	J.S.R	06/02/12	ECN:	CL706
DESIGN REVIEW:	S.K	06/02/12		

MANUFACTURING INFORMATION
MATERIAL: N/A
STANDARD:
MAT. CERT REQ.: No TRACEABILITY REQ.: No
WEIGHT: CAST [kg]: MACHINED [kg]:
ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED
UNTOLERANCED DIMENSIONS & SURFACE FINISH GENERAL: +/- n/a HOLES Ø: +/- 0.2 ANGULAR: +/- 0.5° MACHINED SURFACE FINISH: Ra n/a µm

DRAWING INFORMATION		
TANK,PUMP AND VALVE BLOCK ASSEMBLY (MECS)		
JET / CONTROL TYPE: 362-571		
DRAWN TO HAMJET 085195	PROJECTION:	
SCALE: 1:4	SHEET SIZE A3	Sheet2/5
DWG No.: CTTNK03010		REV: B

ASSEMBLY STEP 3
FIT PUMP ASSEMBLY



NOTE: BELT GUARD AND MANUAL LABEL PLATE OMITTED FOR CLARITY.

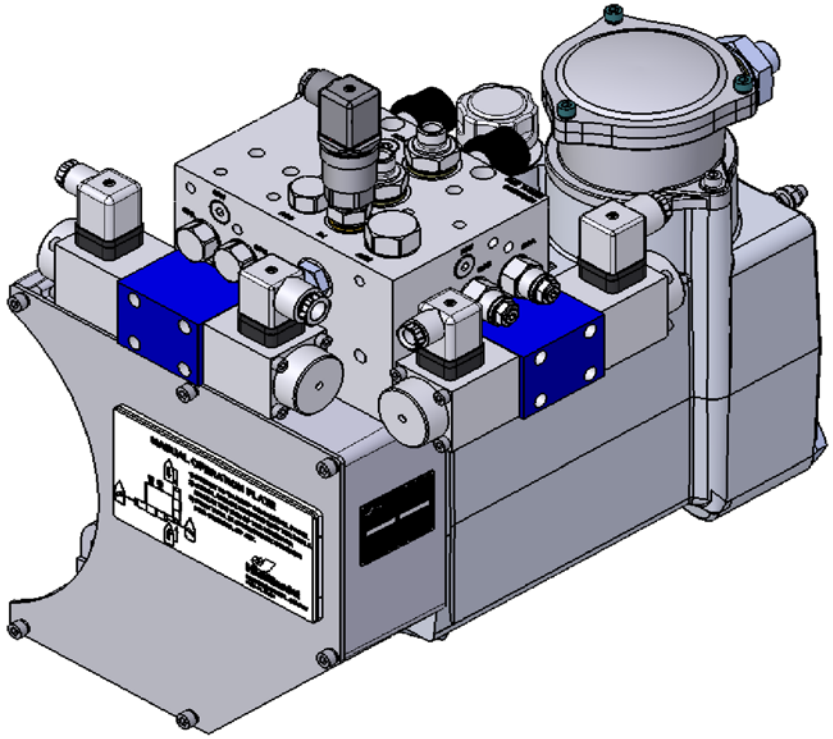
C. W. F. Hamilton & Co. Ltd

CHANGE HISTORY				
LATEST AMENDMENT: B - NEW KIT D CREATED, REMOVED ITEM 21 AND ADDED ITEM NO. 30,31,32,33,34 TO BOM. A - ISSUED FOR PRODUCTION				
AMENDED BY:	J.S.R.	05/03/12	ECN:	CL709
AMENDMENT REVIEW:	S.K	05/03/12		
DESIGNED BY:	J.S.R	06/02/12	ECN:	CL706
DESIGN REVIEW:	S.K	06/02/12		

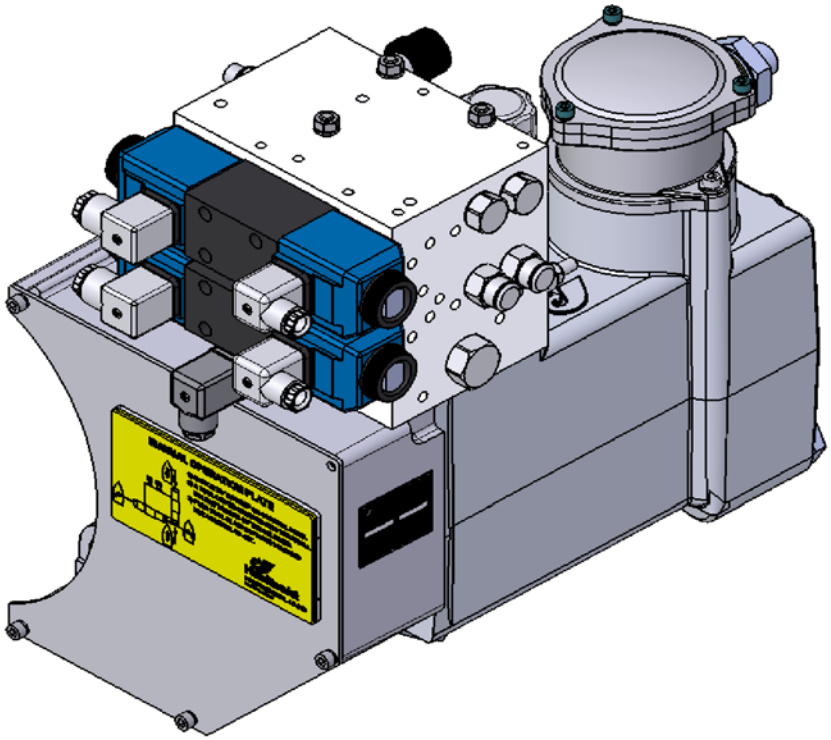
MANUFACTURING INFORMATION
MATERIAL: N/A
STANDARD:
MAT. CERT REQ.: No TRACEABILITY REQ.: No
WEIGHT: CAST [kg]: MACHINED [kg]:
ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED
UNTOLERANCED DIMENSIONS & SURFACE FINISH GENERAL: +/- n/a HOLES Ø: +/- 0.2 ANGULAR: +/- 0.5° MACHINED SURFACE FINISH: Ra n/a µm

DRAWING INFORMATION		
TANK,PUMP AND VALVE BLOCK ASSEMBLY (MECS)		
JET / CONTROL TYPE: 362-571		
DRAWN TO HAMJET 085195	PROJECTION:	
SCALE: 1:3	SHEET SIZE A3	Sheet3/5
DWG No.: CTTNK03010		REV: B

DWG No CTTNK03010 B



KIT A,B AND D



KIT C

DWG No CTTNK03010 B

C. W. F. Hamilton & Co. Ltd					This print is provided on a restricted basis and is not to be used in any way detrimental to the interests of C. W. F. Hamilton and Co. Ltd
CHANGE HISTORY					**MANUFACTURING INFORMATION**	**DRAWING INFORMATION**
LATEST AMENDMENT: **B - NEW KIT D CREATED, REMOVED ITEM 21 AND ADDED ITEM NO. 30,31,32,33,34 TO BOM.** **A - ISSUED FOR PRODUCTION**					MATERIAL: **N/A** STANDARD: MAT. CERT REQ.: **No** TRACEABILITY REQ.: **No** WEIGHT: CAST [kg]: MACHINED [kg]: **ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED** **UNTOLERANCED DIMENSIONS & SURFACE FINISH** GENERAL: +/- n/a HOLES Ø: +/- 0.2 ANGULAR: +/- 0.5° MACHINED SURFACE FINISH: Ra **n/a** µm	**TANK,PUMP AND VALVE BLOCK ASSEMBLY (MECS)** JET / CONTROL TYPE: **362-571** DRAWN TO HAMJET 085195 PROJECTION: SCALE: **1:3** SHEET SIZE **A3** **Sheet4/5** DWG No.: **CTTNK03010** REV: **B**
AMENDED BY:	**J.S.R.**	**05/03/12**	ECN:	**CL709**		
AMENDMENT REVIEW:	**S.K**	**05/03/12**				
DESIGNED BY:	**J.S.R**	**06/02/12**	ECN:	**CL706**		
DESIGN REVIEW:	**S.K**	**06/02/12**				

	A	B	C	D	Item	Kit	PartNumber	ProductDescription	DrawingNumber
						A	CTTNK03010	TANK, PUMP AND VALVE BLOCK SUB ASSEMBLY -(362 MECS)	CTTNK03010
						B	CTTNK03011	TANK, PUMP AND VALVE BLOCK SUB ASSEMBLY -(391 MECS -571 MECS)	CTTNK03010
						C	CTTNK03012	TANK, PUMP AND VALVE BLOCK SUB ASSEMBLY -(364 MECS)	CTTNK03010
B						D	CTTNK03018	TANK, PUMP AND VALVE BLOCK SUB ASSEMBLY -(571 MECS) RIGHT HAND ROTATION OPTION	CTTNK03010
	A1	B1	C1	D1	1		111470	TANK BODY J.H.P.U (HJ362 - HM571) - VERSION 4	111470
	A2	B2	C2	D2	2		030850	(SCREWS) (CAPSCREWS) METRIC ST ST 316 SOCKET Hd M8x25	N/A
	A2	B2	C5	D2	3		201394	(WASHERS) (SPRING) METRIC ST ST 316 M8	N/A
	A3	B3	C3	D3	4		201262	(SCREWS) (CAPSCREWS) METRIC ST ST 316 SOCKET Hd M6x20	N/A
	A3	B3	C3	D3	5		201392	WASHER SPRING M6 SS316	N/A
	A1	B1	C1	D1	6		201769	BONDED SEAL 3/4" BSP (400-827-4490-74)	115000
	A1	B1	C1	D1	7		201770	BONDED SEAL 1.0 " BSP (400-830-4490-74)	N/A
	A1	B1	C1	D1	8		205055	PLUG 3/4"BSPP MALE # Z107012	115000
	A1		C1		9.1		205069	NIPPLE1/2" BSPP MALE x 1.0" BSPP MALE # Z10200816	115000
		B1		D1	9.2		205071	NIPPLE 3/4" BSPP MALE x 1.0" BSPP MALE # Z10201216	115000
	A1	B1	C1	D1	10		107142	"P" PORT TUBE	107142
	A1	B1	C1	D1	11		200962	(O RINGS) IMPERIAL 0.10x0.81x1.0" (117N70)	N/A
	A1	B1	C1	D1	12		200960	(O RINGS) IMPERIAL 0.10x0.63x0.81 (114N70)	N/A
	A1	B1	C1	D1	13		065049	IKRON TANK MOUNTED RETURN LINE FILTER (HHR10506)	N/A
					14	REF	065050	IKRON RETURN LINE FILTER ELEMENT (HHC03577)	CTHPU10002
	A1	B1	C1	D1	15		064783	JHPU OIL RESERVOIR DIPSTICK 70mm	110735
	A1	B1	C1	D1	16		065028	IKRON FILLER/BREATHER - (HB50-A-8-L-1-05-H-1-R)	N/A
			C3		18		203740	(STUDS) METRIC (316-STST) M8x176 (16/16)	30647
	A3	B3	C3	D3	19		201207	(SCREWS) (M/C SCREWS) METRIC ST ST 316 M5x10 (PAN HEAD)	N/A
			C3		20		201309	(NUTS) (METRIC ST ST 316) M8	N/A
	A3	B3		D3	22		030737	(SCREWS) (CAPSCREWS) METRIC ST ST 316 SOCKET HD M8x90	N/A
	A1				23		CTVLV04042	PROPORTIONAL VALVE BLOCK (HJ362 MECS)	CTVLV04042
		B1		D1	23		CTVLV04043	PROPORTIONAL VALVE BLOCK (391MECS -571 MECS)	CTVLV04042
			C1		23		CTVLV04047	PROPORTIONAL VALVE BLOCK (364 MECS)	CTVLV04045
	A1		C1		24		CTPMP01010	PUMP ASSEMBLY FOR JHPU (362 MECS AND 364 MECS)	CTPMP01010
		B1			24		CTPMP01011	PUMP ASSEMBLY FOR JHPU (391MECS -571 MECS)	CTPMP01010
B				D1	24		CTPMP01017	PUMP ASSEMBLY FOR JHPU (571 R.H ROTATION)	
	A1	B1	C1	D1	25		200984	(O RINGS) IMPERIAL 0.13x5.38x5.63 (253N70)	N/A
	A1	B1	C1	D1	26		201395	(WASHERS) (SPRING) METRIC ST ST 316 M10	N/A
	A1	B1	C1	D1	27		201228	(SCREWS) (M/C SCREWS) METRIC ST ST 316 HEX HD M10x35	N/A
	A3	B3	C3	D3	28		201277	(SCREWS) (CAPSCREWS) METRIC ST ST 316 SOCKET HD CSK M8x40	N/A
	A3	B3	C3	D3	29		111615	PAINT APPLICATION JHPU'S WITH CAST TANK (STD) GLOSS FINISH	111178
B	A4	B4			30		109847	(STUDS) METRIC (316-STST) M8x36 (17/17)	30647
B	A4	B4			31		201330	NUT NYLOC M8 SS316	N/A
B	A4	B4			32		201383	WASHER FLAT M8x16x1.2 SS316	N/A
B			C4		33		201246	(SCREWS) (SET SCREWS) METRIC ST ST 316 SOCKET M8x16	N/A
B	A1	B1	C1	D1	34		201244	(SCREWS) (SET SCREWS) METRIC ST ST 316 Socket M6x10	N/A

DWG No CTTNK03010 B

C. W. F. Hamilton & Co Ltd

CHANGE HISTORY

LATEST AMENDMENT:
B - NEW KIT D CREATED, REMOVED ITEM 21 AND ADDED ITEM NO. 30,31,32,33,34 TO BOM.
A - ISSUED FOR PRODUCTION

AMENDED BY:	J.S.R.	05/03/12	ECN:	CL709
AMENDMENT REVIEW:	S.K	05/03/12		
DESIGNED BY:	J.S.R	06/02/12	ECN:	CL706
DESIGN REVIEW:	S.K	06/02/12		

MANUFACTURING INFORMATION

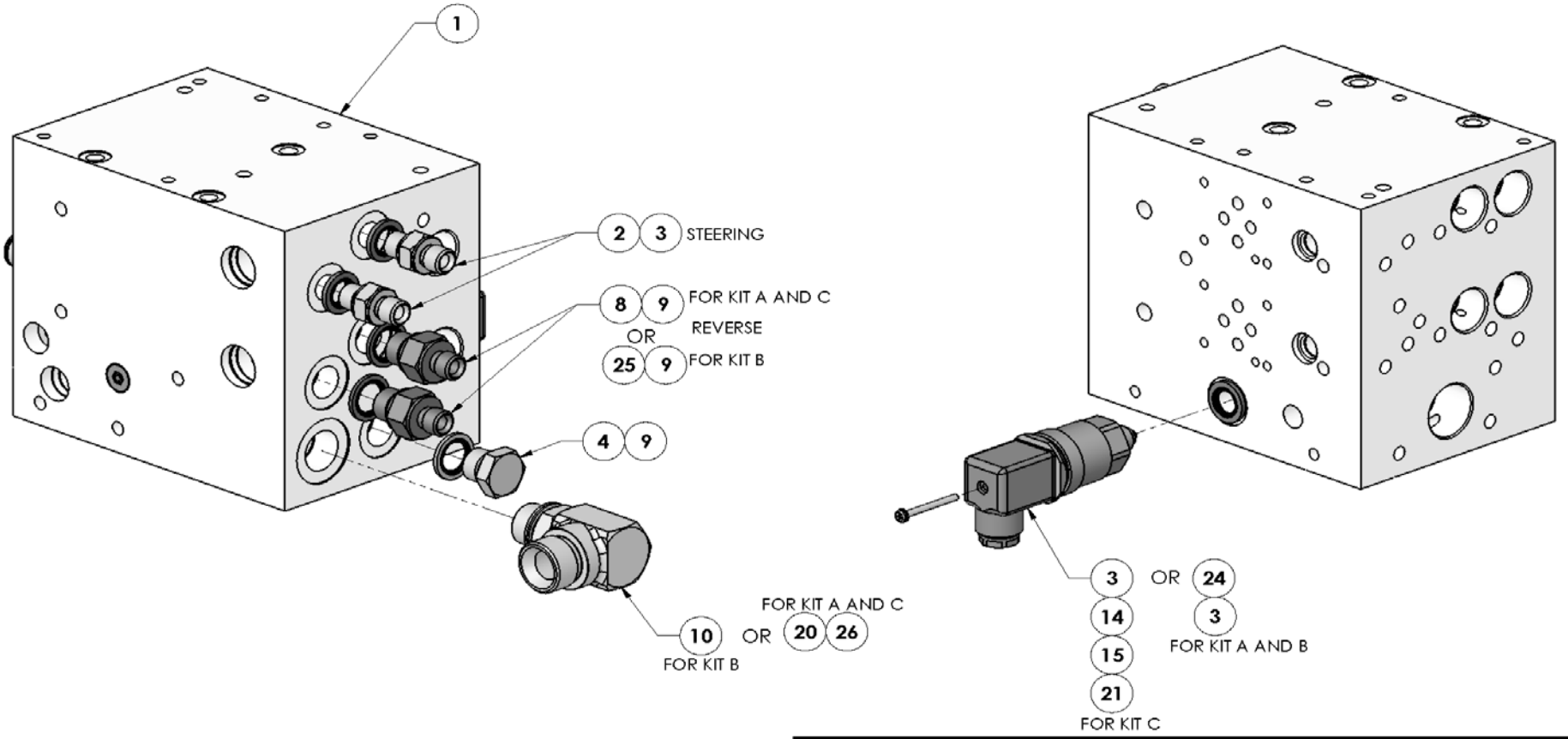
MATERIAL: **N/A**
STANDARD:
MAT. CERT REQ.: **No** TRACEABILITY REQ.: **No**
WEIGHT: CAST [kg]: MACHINED [kg]:
ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED
UNTOLERANCED DIMENSIONS & SURFACE FINISH
GENERAL: +/- n/a HOLES Ø: +/- 0.2 ANGULAR: +/- 0.5°
MACHINED SURFACE FINISH: Ra **n/a** µm

DRAWING INFORMATION

TANK,PUMP AND VALVE BLOCK ASSEMBLY (MECS)

JET / CONTROL TYPE: **362-571**
DRAWN TO HAMJET 085195 PROJECTION:
SCALE: **1:5** SHEET SIZE **A3** **Sheet5/5**
DWG No.: **CTTNK03010** REV: **B**

ASSEMBLY STEP 1
FIT HOSE FITTINGS,BONDED SEALS AND PLUGS



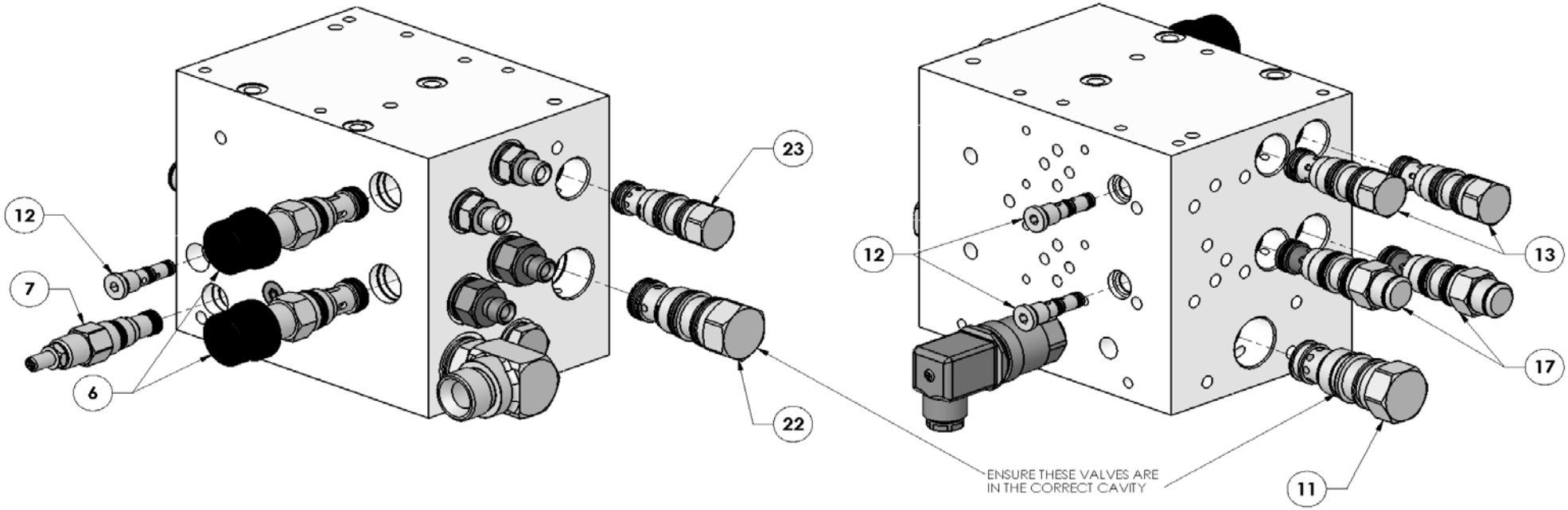
HamiltonJet

CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS				
REVISION: C ECN: 20485				
KIT D,H & J ADDED TO BOM				
DESIGN CHECK:	N.T.	5/12/2012	SIGN:	
DRAWING REVISION:	J.S.R.	4/12/2012	SIGN:	
DOCUMENT CHECK:	N.T.	5/12/2012	SIGN:	
ORIGINAL DESIGN:	J.S.R.	6/02/2012	SIGN:	

MANUFACTURING INFORMATION
MATERIAL: N/A
STANDARD: N/A
MAT CERT REQ: No TRACEABILITY REQ: No
FINISHED WEIGHT: N/A [kg]
ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED
REMOVE ALL SHARP EDGES & BURRS
UNTOLERANCED DIMENSIONS & SURFACE FINISH GENERAL: +/- N/A HOLES: Ø N/A ANGULAR: N/A MACHINED SURFACE FINISH: Ra N/A µm

DRAWING INFORMATION			
PROPORTIONAL VALVE BLOCK ASSEMBLY			
JET / CONTROL TYPE: 364.403			
DRAWN TO HAMJET 085195	PROJECTION:		
SCALE: 1:2	SHEET SIZE: A3	Sheet 1/4	
DWG No: CTVLV04045		REV: C	

ASSEMBLY STEP 2
FIT CARTRIDGE VALVES



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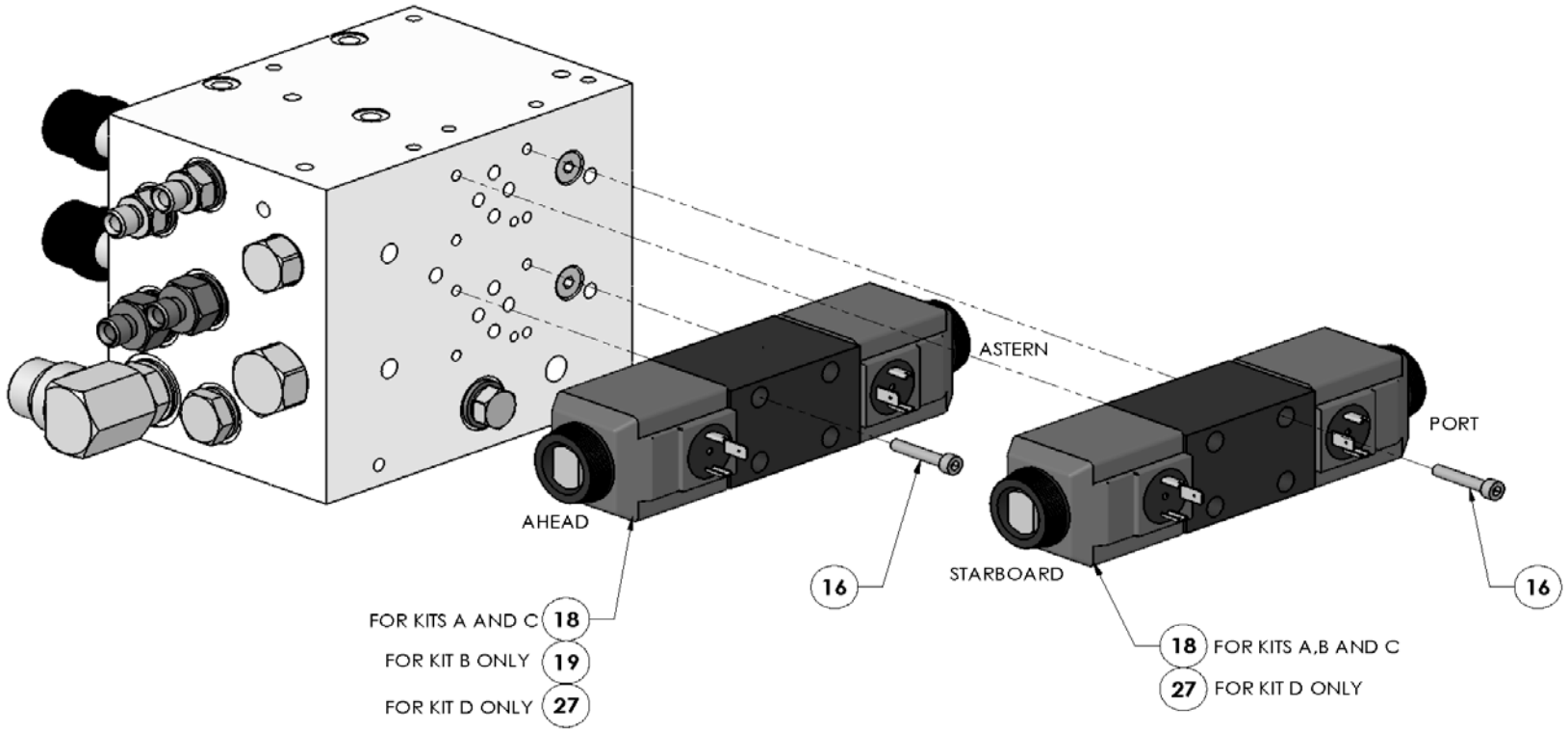
CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS				MANUFACTURING INFORMATION	DRAWING INFORMATION
REVISION: C ECN: 20485 KIT D,H & J ADDED TO BOM				MATERIAL: N/A STANDARD: N/A MAT CERT REQ: No TRACEABILITY REQ: No FINISHED WEIGHT: N/A [kg]	PROPORTIONAL VALVE BLOCK ASSEMBLY
DESIGN CHECK:	N.T.	5/12/2012	SIGN:	ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED	JET / CONTROL TYPE: 364.403
DRAWING REVISION:	J.S.R.	4/12/2012	SIGN:	REMOVE ALL SHARP EDGES & BURRS	DRAWN TO HAMJET 085195 PROJECTION:
DOCUMENT CHECK:	N.T.	5/12/2012	SIGN:	UNTOLERANCED DIMENSIONS & SURFACE FINISH GENERAL: +/- N/A HOLES: Ø N/A ANGULAR: N/A	SCALE: 1:2 SHEET SIZE: A3 Sheet 2/4
ORIGINAL DESIGN:	J.S.R.	6/02/2012	SIGN:	MACHINED SURFACE FINISH: Ra N/A µm	DWG No: CTVLV04045 REV: C

ASSEMBLY STEP 3
FIT SOLENOID VALVES



HamiltonJet

CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS				MANUFACTURING INFORMATION	DRAWING INFORMATION
REVISION: C ECN: 20485 KIT D,H & J ADDED TO BOM				MATERIAL: N/A STANDARD: N/A MAT CERT REQ: No TRACEABILITY REQ: No FINISHED WEIGHT: N/A [kg]	PROPORTIONAL VALVE BLOCK ASSEMBLY
DESIGN CHECK:	N.T.	5/12/2012	SIGN:	ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED	JET / CONTROL TYPE: 364.403
DRAWING REVISION:	J.S.R.	4/12/2012	SIGN:	REMOVE ALL SHARP EDGES & BURRS	DRAWN TO HAMJET 085195 PROJECTION:
DOCUMENT CHECK:	N.T.	5/12/2012	SIGN:	UNTOLERANCED DIMENSIONS & SURFACE FINISH GENERAL: +/- N/A HOLES: Ø N/A ANGULAR: N/A MACHINED SURFACE FINISH: Ra N/A µm	SCALE: 1:2 SHEET SIZE: A3 Sheet3/4
ORIGINAL DESIGN:	J.S.R.	6/02/2012	SIGN:		DWG No: CTVLV04045 REV: C

A	B	C	D	E	F	G	Item	Kit	Part Number	Product Description	Drawing
								A	CTVLV04045	PROPORTIONAL VALVE BLOCK (364 BLUE ARROW)	CTVLV04045
								B	CTVLV04046	PROPORTIONAL VALVE BLOCK (403 BLUE ARROW)	CTVLV04045
								C	CTVLV04047	PROPORTIONAL VALVE BLOCK (364 MECS)	CTVLV04045
								D	CTVLV04051	PROPORTIONAL VALVE BLOCK (364 AVX)	CTVLV04045
		C1						E	203650	KIT - DANFOSS PRESSURE TRANSDUCER	CTVLV04042
A2	B1	C2						F	210314	KIT - PROPORTIONAL VALVE (KDG4V-3S-33C08A-M-U-G5-60)	CTVLV04045
	B1							G	210315	KIT - PROPORTIONAL VALVE (KDG4V-3S-33C15A-M-U-G5-60)	CTVLV04045
A1	B1	C1	D1				1		203734	(HYDRAULIC) JHPU VALVE BLOCK CT-L PROP REV, STG. (IHL, HDM11809)	203734
A2	B2	C2	D2				2		205062	NIPPLE 1/4" BSPP MALE x 1/4" BSPP MALE (# Z101004)	N/A
A3	B3	C2	D3	E1			3		201766	BONDED SEAL 1/4" BSP (# 400-821-4490-74)	N/A
A1	B1	C1	D1				4		205053	PLUG 3/8"BSPP MALE (# Z107006)	N/A
A2	B2	C2	D2				6		064828	(MV*) NEEDLE VALVE (SUN NFCD-KFN) M20x1.5 (45-50Nm)	N/A
A1	B1	C1	D1				7		201835	(PRV) RELIEF VALVE ,SUN-RDBA-LAN PRESSURE SET TO 103 BAR (1500 psi) M16x1.5 (35-40Nm)	CTHPU09000
A2		C2	D2				8		205063	NIPPLE 1/4" BSPP MALE x 3/8" BSPP MALE (# Z10200406)	N/A
A3	B3	C3	D3				9		201767	BONDED SEAL 3/8" BSP (# 400-823-4490-74)	N/A
	B1						10		064796	POSITIONAL ELBOW 3/4" BSPP 1/2" BSPP 90 DEGREE (# SB10131208)	N/A
A1	B1	C1	D1				11		064777	(MBV) BYPASS COMPENSATOR,(SUN, #LRFC-XGN)	N/A
A3	B3	C3	D3				12		064264	(*SV) SHUTTLE VALVE (COMMAND BDSV-4-N-3-0)	N/A
A2	B2	C2	D2				13		064779	(SP*) PILOT OPERATED CHECK VALVE (SUN, #CKCD-XCN) M20x1.5 (45-50Nm)	N/A
				E1			14		206146	SCREW M/C M3x40 SS304 PAN PHIL	N/A
				E1			15		064788	(WASHERS) (METRIC NYLON) M3x1.6 THK (HI-Q #03-3NB1.6)	N/A
			D8		F4	G4	16		030738	(SCREWS) (CAPSCREWS) METRIC ST ST 316 SOCKET HD M5x30	N/A
A2	B2	C2	D2				17		201838	(RC*) COUNTERBALANCE VALVE ,SUN-CBCA-LHN PRESSURE SET TO 90 BAR (1300 psi)	CTHPU09000
					F1		18		203739	VICKERS PROPORTIONAL VALVE 12 VOLT (KDG4V-3S-33C08A-M-U-G5-60)	N/A
						G1	19		203738	VICKERS PROPORTIONAL VALVE 12 VOLT (KDG4V-3S-33C15A-M-U-G5-60)	N/A
A1		C1	D1				20		205067	NIPPLE 1/2" BSPP MALE x 1/2" BSPP MALE (# Z101008)	N/A
				E1			21		065346	DANFOSS PRESSURE TRANSDUCER # MBS3000 060G1107 (0-100 BAR) G1/4A (55-60Nm)	N/A
A1	B1	C1	D1				22		064816	(RCV) RESTRICTIVE COMPENSATOR (SUN, #LPFC-XGN)	N/A
A1	B1	C1	D1				23		064780	(SCV) RESTRICTIVE COMPENSATOR (SUN, #LPDC-XGN)	N/A
A1	B1		D1				24		205052	PLUG 1/4" BSPP MALE (# Z107004)	N/A
	B2						25		205065	NIPPLE 3/8" BSPP MALE x 3/8" BSPP MALE (# Z101006)	N/A
A1		C1	D1				26		201768	BONDED SEAL 1/2" BSP (# 400-825-4490-74)	N/A
			D2				27		208452	VICKERS PROPORTIONAL VALVE 24VOLT (KDG4V-3S-33C08A-M-U-H5-60)	N/A

HamiltonJet

CHANGE SUMMARY - REFER TO E.C.N. FOR DETAILS

REVISION: C ECN: 20485

KIT D,H & J ADDED TO BOM

DESIGN CHECK:	N.T.	5/12/2012	SIGN:
DRAWING REVISION:	J.S.R.	4/12/2012	SIGN:
DOCUMENT CHECK:	N.T.	5/12/2012	SIGN:
ORIGINAL DESIGN:	J.S.R.	6/02/2012	SIGN:

MANUFACTURING INFORMATION

MATERIAL: N/A

STANDARD: N/A

MAT CERT REQ: No TRACEABILITY REQ: No

FINISHED WEIGHT: N/A [kg]

ALL DIMENSIONS IN [mm] UNLESS OTHERWISE SPECIFIED

REMOVE ALL SHARP EDGES & BURRS

UNTOLERANCED DIMENSIONS & SURFACE FINISH

GENERAL: +/- N/A HOLES: Ø N/A ANGULAR: N/A

MACHINED SURFACE FINISH: Ra N/A µm

DRAWING INFORMATION

PROPORTIONAL VALVE BLOCK ASSEMBLY

JET / CONTROL TYPE: 364,403

DRAWN TO HAMJET 085195 PROJECTION:

SCALE: 1:2 SHEET SIZE: A3 Sheet 4/4

DWG No: CTVLV04045 REV: C

12 - Commissioning Check Sheet

In This Section

Warnings and Cautions

Make sure that the vessel is securely moored during commissioning, as the Jet Unit can produce large thrust forces.

Shaft may rotate unexpectedly during setup – ***KEEP CLEAR***

All rotating parts between the engine and the Water Jet Unit must be covered. This will:

- Avoid personal injury
- Protect the shaft from foreign objects

Protect personal in case of shaft failure

230-440VAC Mains voltages are present at Auxilliary and lube pumps and starter boxes.

If any problems are found during vessel testing, they must be fixed before proceeding.

Operating a vessel with control system faults may cause personal injury and equipment damage.

Check that the stern of the vessel is clear of debris and vessels etc…

Make sure that the Jet Intake, Nozzle and Reverse Ducts are free of debris and foreign objects.

Pinch and crush hazards are present on the Water Jet Unit

Make sure that all Bearing Housings and JHPU Tanks are filled with the correct quantity and grade of oil

Before sea trials, make sure there are no oil or water leaks.

Do not run the Jet Unit out of the water unless it is fitted with a Dry Run Kit.

Project Details

Project Number	
Date	
Engineer	
Main Engine Type	
Transmission	
Control System Type	
Control System Version	
Yard Number	
Hull Number	
Vessel Name	
Class Notation	
Survey Authority	

Jet #	1	2	3	4	5	6
Serial #						

Module	Serial Numbers					
JCM						
CPM - St1						
CPM - St2						
CPM - St3						
CPM - St4						
ECM						
PIM						
JJB						
HHR						
HHRJB						
API						
DPI						
SLC						
Helm						
Joystick						
Tiller						
VDRI						
MJM						
Lube Pump Starter						
Aux HPU starter						

Basic System Checks

	Check	Completed 1 2 3 4
1	The JHPU oil reservoirs have been filled with oil.	☐ ☐ ☐ ☐
2	The jet bearing oil reservoirs have been filled with oil.	☐ ☐ ☐ ☐
3	Lube oil pump rotation and operation manually	☐ ☐ ☐ ☐
4	The Auxiliary JHPU pump rotation is correct	☐ ☐ ☐ ☐
5	No oil leaks.	☐ ☐ ☐ ☐
6	The hydraulic drive belts have been correctly tightened.	☐ ☐ ☐ ☐
7	The spare drive belts have been securely fitted over the drive shaft and cannot get caught on any rotating machinery.	☐ ☐ ☐ ☐
8	Check hydraulic cylinders are unwrapped and all sliding surfaces are clean and un damaged.	☐ ☐ ☐ ☐
9	Bellow vents are open and vent kit fitted correctly	☐ ☐ ☐ ☐
10	All modules except JJB's have been bonded to the hull with 2.5mm earth conductors.(Ensure JJB is isolated from Jet unit).	☐
11	Shaft bonding brush assembly on jet unit is in tact	☐ ☐ ☐ ☐
12	Record Hull - Jet potentials for corrosion prevention in accordance with "Corrosion Survey Procedure" PRO-0019	☐
13	All unused connectors have sealing caps fitted and that unused cable glands have seals to prevent water ingress	☐
14	The polarity of the jet power supplies is correct.	☐ ☐ ☐ ☐
15	All modules have been securely mounted and that all jet control cables have been securely cabled tied in place.	☐
16	The jet and engine modules have been labelled or that it is obvious which jet control module and which engine control module controls which jet and which engine	☐
17	The CAN bus terminators are fitted in accordance with the ships schematic	☐
18	Check that the BACKUP terminators are fitted in accordance with the ships schematic	☐
19	All connectors are in the right place (in accordance with schematics) and free of dust swarf damage etc	☐
20	Field wiring by yard or other is correct and in accordance with schematics including throttle demand, gear demands and feedbacks, interlocks etc	☐

Control Tests at the Jet (In Jet or Engine room)

	Check	Completed
21	Switch the Power On to the MECS system.	☐
22	Reset all modules to defaults	☐
23	Do the system setup to assign modules and jet numbers	☐
24	Set module parameters, note vessel specifics, yard or class requirements in accordance with schematics	☐
25	Calibrate all CID's at all stations	☐
26	Check throttle demand signals are correct for the engine type and in accordance with schematics	☐
27	Make sure the MECS control system is operating error free	☐

Do the following Tests one Jet at a time

		1	2	3	4
28	Start engine and switch to remote	☐	☐	☐	☐
29	Set JCM to backup and Check engine demand and gear control is functioning at the ECM for each jet (one jet in drive at a time) in LOCAL 1	☐	☐	☐	☐
30	Check engine demand and gear control is functioning at the ECM for each jet in LOCAL 2	☐	☐	☐	☐
31	Where there is a bearing oil cooler pump, check that this pump operates automatically when the jet is in drive.	☐	☐	☐	☐
32	Check for leaks when gears are engaged	☐	☐	☐	☐
33	IMPORTANT! Check for clearance and bucket/nozzle collisions with the vessel etc…	☐	☐	☐	☐
34	Stroke hydraulics manually to purge air (in backup)	☐	☐	☐	☐
35	Check and set the steering speed and reverse duct speeds of all the jets are the same	☐	☐	☐	☐
36	Switch the JCM back to normal, and perform a jet setup (per jet)	☐	☐	☐	☐
37	Disengage, switch ECM to remote	☐	☐	☐	☐

Control Tests at the Bridge

	Check	Completed 1	2	3	4
38	With the jet power on, and the jets in 'Normal', Check: ▪ The MECS control system is error free. ▪ Each control panel display should only be showing two dots. The left dot should be flashing and the right dot should be on and steady on every control panel module	☐	☐	☐	☐
39	Set all reverse levers to the zero speed position and all helm controls to the straight ahead position. Take control at the main station and one at a time start the engine and where there is a gearbox check the operation of the gearbox buttons and indicating lamps on the control panel. Where there is no gearbox, the lamp should indicate neutral and this should change to drive once the engine is started.	☐	☐	☐	☐
40	When in 'Drive' check that the zero speed position creates no ahead or astern movement of the boat.	☐	☐	☐	☐
41	Switch to Backup on that jet and check that the zero speed position creates no ahead or astern movement of the boat.	☐	☐	☐	☐
43	Start all engines and engage 'Drive'. Operate the steering from full port to full starboard. Check that the control panels all display synchronized steering nozzle movement. Note that if some jets have some non zero 'Helm Curve' parameters set then those jets will move less than the others for small helm movements.	☐	☐	☐	☐
44	Slowly move the control levers, one at a time, checking for reverse duct movement indication on all control panel displays and that the engine rpm increases from idle. Do not rev the engine beyond a fast idle at this stage.	☐	☐	☐	☐
45	Press and hold each 'RPM +' button in turn and check that the rpm increases. Check that each 'RPM –' button decreases the engine rpm.	☐	☐	☐	☐
46	Press the 'Cancel' button for a few seconds on every control panel, one at a time. Check that all lamps on all the control panels and the helm 'Take Control' lamp on that station illuminate and the sounder operates	☐	☐	☐	☐
47	Press the 'Dimmer' button on each control panel a number of times. Check that the lamps at all control panels on that station dim down increasingly after each button press.	☐	☐	☐	☐
48	Switch to backup on each jet and check operation of the gearbox buttons, Jogstick, display and engine rpm controls.	☐	☐	☐	☐
49	Where there are other control stations, take control at each one in turn and repeat the above tests to check the functions (tests 43 to 48).	☐			
50	Check that with a control lever set to approximately 1/4 ahead at the station in control that control cannot be taken by any other station. Check all stations in a similar manner.	☐			
51	Check that the control cannot be taken when the station in control has been locked. Check locking on all stations	☐			
52	Stop the engines. Check that with a control lever set to approximately 1/4 ahead at the station in control that every engine cannot be started. Check engine start interlock on all stations.	☐	☐	☐	☐
53	With the jet power on but without the engines running, turn off the circuit breakers for the primary jet supply. Check that a J1 alarm is indicated on the control panel module displays for that jet (or jets) and the jet controls still function.	☐	☐	☐	☐
54	Repeat the above test for the secondary jet supply. Check that a J2 alarm is generated and ensure jet controls still function.	☐	☐	☐	☐
55	Check and setup API Module if fitted	☐			

		Completed			
	Check	1	2	3	4
56	Check and setup DPI module if fitted	☐	☐	☐	☐
57	Check and setup VDR module if fitted	☐			
58	Check operation of alarm sensors as required	☐	☐	☐	☐
59	Check local and remote indication of class required sensors is correct if required (refer to survey testing documentation)	☐	☐	☐	☐
60	Undertake an FMEA if required by the yard or class	☐			

Checks to be done at sea

		Completed			
	Check	1	2	3	4
61	Clear the alarm log before sea trials	☐			
62	Before leaving the dock check backup and normal controls are functioning correctly	☐			
63	Verify DPI module is operating correctly when vessel is underway	☐	☐	☐	☐
64	Verify the VDRI is operating correctly	☐			
65	Verify MECS system is operating without alarm and functioning correctly	☐			
66	Check the manoeuvring devices are setup and operating correctly. Adjust accordingly.	☐			
67	Verify zero speed adjustment is set correctly	☐			
68	Where there is a autopilot, check that the vessel holds a straight course when under autopilot control.	☐			
69	Periodically measure the temperature of the jet bearing and JHPU oil reservoirs. Check that the temperature does not rise above 65°C	☐	☐	☐	☐
70	Observe and Undertake an power assisted slowdown (emergency stop) if required by the yard or class	☐			

Power assisted slowdown produces very rapid deceleration.

Power assisted slowdown should be used with care by new operators.

Do not use full helm control until the vessel has slowed.

Select zero speed as soon as the vessel has slowed.

Final Checks/Tasks

	Check	Completed
72	Clear alarm logs before leaving vessel	☐
73	Record all module parameters in the tables below…	☐
74	Check that any modules that have been opened have been left in a clean and tidy condition inside.	☐
75	Record any warranty related issues	☐
76	Photograph non-standard parts or installations to attach to the project log	☐
77	Obtain copies of the survey and yard test sheets for the propulsion system if available	☐

Parameters

The following tables contain details of parameters associated with each module.

- {A} - Automatic parameter which is set by the system during module set-up ALL.
- {F} - Factory parameter, not available via the Jet Set-Up menu.

JCM Setup Password _____

As at Date _____

Control Panel Module

#	Name	Station 1				Station 2				Station 3				Default
		P1	P2	S3	S4	P1	P2	S3	S4	P1	P2	S3	S4	
1	Helm Type													Hlm
2	Helm 1 Curve													0
3	No. Of Levers													1
4	Ctrl2Type													None
5	Helm2 Curve													0
6	Centre JetBias													2
7	Port Helm													0x10
8	Stbd Helm													0xf0
9	Mid Helm													0x80
10	Rev Fwd													0xf00
11	Rev Back													0x100
12	Rev Mid													0x800
13	Thrtle Fwd													0xf00
14	Thrtle Back													0x100
15	Helm2 Port													0x10
16	Helm2 Stbd													0xf0
17	Helm2 Mid													0x80
18	DCM limits													
19	DCM centre													
20	DCM Z Prt													0x10
21	DCM Z Stb													0xf0
22	DCM Z Mid													0x80
23	DCM trim													0.0
24	Jet sepr													3.5
25	Dist LCG													10.0
26	Deadrise													15.0
27{F}	AnagFilt													12
28{F}	Dim Type													Lamp
29{F}	CntrJetThtlEn													No
30{F}	Lock disable													No
31{F}	NonZeroXfer													No
32{F}	Beep Type													2
33{F}	ThLim maste													No
34{F}	Throt limit													100
35{F}	DCM X Max													0xf0
36{F}	DCM X Min													0x10
37{F}	DCM X Mid													0x80
38{F}	DCM Y Max													0xf00
39{F}	DCM Y Min													0x100
40{F}	DCM Y Mid													0x800
41{F}	DCM AsideTh													31%
42{F}	DCM AheadTh													15%
43{F}	DCM AsternT													15%
44{F}	DCM SLC th													31%
45{F}	DCM Helm Th													31%
46{F}	DCM Ramp tic													0.0
47{F}	DCM Fwd lim													42%
48{F}	DCM CurvAhd													12%
49{F}	DCM CurvAsi													50%
50{F}	AP Override													5
51{F}	Panel S/W V													

Jet Control Module (JCM)

#	Name	P1	P2	S3	S4	Default
1{A}	Starbd Db					30
2{A}	Port Db					30
3{A}	Stbd Fb					0xC8
4{A}	Port Fb					0x32
5{A}	Rev.Up Db					30
6{A}	Rev.Dn Db					30
7{A}	Rev.Up Fb					0xd00
8{A}	Rev.Dn Fb					0x250
9	StrgMid Fb					0x80
10	RevNeut Fb					0x500
11{F}	Steering Kp					28
12{F}	Rev. Up Kp					28
13{F}	Rev. Dn Kp					28
14{F}	Strg AlTime					3
15{F}	Rev. AlTime					3
16{F}	Strg HydMax					110
17{F}	Up HydrMax					110
18{F}	Down HydMax					110
19{F}	LinearRevMax					9
20{F}	SteeringErr					2
21{F}	ReverseErr					20
22{F}	MaxOilTemp					65
23{F}	MinOilP					3
24{F}	StrDbOffSet					2
25{F}	RevDbOffSet					2
26{F}	Bearing Temp					0
27{F}	BrgOilLevel					0
28{F}	AnalogFilt					14
29{F}	Integratn K					12
30{F}	ExtrnHydrlc					0
31{F}	JCM S/W V?.?					

Engine Control Module (ECM)

#	Name	Jet 1	Jet 2	Jet 3	Jet 4	Default
1	Eng Type					MTU
2	Thtle Type					PWM
3	PWM Freq					500
4	PWM Min					4
5	PWM Max					96
6	Min Freq					100
7	Max Freq					500
8	Max Idle					25
9	Max Rev					100
10	Ramp Spd					2
11	Alrm Tmp					110
12	FBK Min					40
13	FBK Max					1000
14	Wmup Cntl					Off
15	Wmup Temp					40
16	Wmup RPM					25
17	Idle Reset					Off
18	Ttle Sync					Off
19	SyncThErr					3
20	Ttle Ilock					On
21	Thrtle Los					Off
22	Clsd Loop					Off
23	Gbx Type					3Sol
24	GbFbk Type					3Sig
25	GbFbk Inv					0
26	MovTimout					6
27	ThrtIdle					On
28	A Fbk Drv					240
29	A Fbk Ntl					127
30	A Fbk Rev					16
31	Max Gr Ttl					10
32	Max Gr Rpm					35
33	Ilock Rly					GBll
34{F}	Ilk DrvOn					Off
35{F}	Rpm Fbk					None
36{F}	EngIdleSpd					500
37{F}	EngMaxSpd					2005
38{F}	EngIdleV					1303
39{F}	FbkTmrVal					5
40{F}	GB Ratio					2.17
41{F}	FbkRamp					25
42{F}	XhydEn					None
43{F}	RollShutd					Off
44{F}	RollDelay					1.0
45{F}	RollGBOut					1.0
46{F}	ECM S/W V?.?					

Notes:

Contact us

Access to HamiltonJet is unrestricted with the global headquarters and factory in New Zealand complemented by Company Offices in both the United States of America and the United Kingdom.

This network is further enhanced by authorised factory trained Distributors in over 50 locations worldwide to provide comprehensive logistic support in the form of commissioning assistance, operation and maintenance training programmes and spare parts supply. Additionally, factory-based field technicians are on permanent stand-by to travel anywhere in the world at short notice.

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